MEMOIR 22

PART I
Some El Paso Guide Fossils

PART II
Fossils from the Smith Basin Limestone of the Fort Ann Region

PART III
Fossils from the Fort Ann Formation

PART IV
Merostomes from the Cassinian Portion of the El Paso Group

by ROUSSEAU H. FLOWER

STATE BUREAU OF MINES AND MINERAL RESOURCES
NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY
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Published March 14, 1969

For sale by the New Mexico Bureau of Mines & Mineral Resources
Campus Station, Socorro, N. Mex. 87801—Price $2.00

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PART I

SOME EL PASO GUIDE FOSSILS

Abstract

Fossils from the El Paso group are here figured and described, largely species diagnostic of some horizons or of correlative significance. The forms are listed in the Table of Contents.

Introduction

Here are brought together illustrations and descriptions of some fossils from the El Paso group of New Mexico and western Texas. They are laregly forms which characterize several of the formations or are of correlative significance. The selection is far from being representative. No attempt is made to treat the calcareous algae, abundant and massive at several horizons. As yet these fossils have not yielded taxonomically in such a way that those of the various horizons can be distinguished.

Cephalopods, particularly the endoceroids, supply associations which characterize three main and several minor horizons. The Endoceratida are being treated in a separate work, which has now grown to somewhere around forty plates and a bale of manuscript, and it seems unwise to duplicate any of this work here. The endoceroids supply the main faunal criteria for the recognition of the faunas of the Cooks, the Victorio Hills and the McKelligon formations. Another work in an advanced stage includes the Tarphyceratida, the exogastric cyrtocones and nautilicones, also of considerable faunal significance though less generally abundant. Ellesmeroceratida of the El Paso group were included in a revision of the order already published (Flower, 1964). Some new forms have since come to light.

Sponges are abundant in several horizons from the Cooks formation to the top of the El Paso group; they are particularly characteristic of stromatolitic facies where slender endoceroids and the more rapidly expanding piloceroids are also abundant. The El Paso materials have been entrusted to Dr. Keith Rigby for description, and they promise to yield information of faunal and stratigraphic value. I was tempted to figure some of these, but was unable to find some of my negatives, and the best specimens are on loan.

The residue from which selected forms are described, is a heterogenous lot. A number of the species which characterize several horizons, have been in manuscript for some years, and some have been mentioned, though only broadly identified, in summaries of the El Paso, largely prepared by request for various guidebooks. Delay was caused in part by taxonomic problems in groups of which the writer's knowledge is far from intimate, and in part by the constant hope of obtaining additional and better material.

Dr. Ruedemann (personal communication) remarked, after completing several volumes on the Utica and Lorraine formations and fossils, that he would never again attempt descriptions of general faunas; taxonomy and literature in each systematic group has become so extensive and so intricate, that only specialists can hope to deal with description of new materials properly. Knowledge of the various fossil groups has grown immensely since that time, as shown by the volumes which have already appeared in the American "Treatise of Paleontology."

Adequate specialists in the various major fossil groups are few, and many cannot lay aside current investigations to fulfill various local requirements such as ours. I have felt some obligation to perform this task, even though others could probably do various parts of it better. I have, however, been able to secure valuable help and advice from various specialists, often on generic assignments, and have sponged from them shamelessly in preparing the present work. Dr. G. A. Cooper has all but supplied the description of *Apheoorthis finkelnburgiae,* and has helped with other brachiopods, not all included in the present work. Dr. Lehi Hintze and Dr. Christina Lochman Balk have helped with the trilobites. Dr. Ellis Yochelson has helped with the gastropods, and has initiated some loans from the U.S. National Museum to aid in the comparison of some of our forms. Dr. Jean Berdan has undertaken the description of the few ostracodes yielded by the El Paso group, and Dr. John Pojeta will describe the few pelecypods so far found in another publication. I hope I have acknowledged all adequately, but the work has been long, and my memory is short.

Considerable vexation stems from realization of the fact that even after extensive field work and much preparation, our identifiable material represents only small fragments of the several faunas in the El Paso group. Limestones have rarely yielded good silicified material which can be removed by etching, and with rare exceptions, the calcilutites contain specimens which defy adequate extraction. For the majority of the limestones, the determinable fossils are nearly confined to the cephalopods and the sponges. Two significant silicified faunas have been found in the lower dolomites of the Scenic Drive formation, but in each of them silicification is selective, and while molluscs are well preserved, trilobites, ostracodes and brachiopods are represented by most inadequate remains.

Only a few horizons yield fossils readily by ordinary chopping and extraction. Others may yield occasional specimens under propitious conditions of weathering. Such conditions are rare, and yield in some cases species represented by single specimens. Such forms largely require additional material for proper description. The species here figured and described are, for the most part, those I have found abundant in and characteristic of several horizons in the El Paso group.

With a nearby source of supply, many descriptions have been delayed in the hope of obtaining better material. It is a hitherto unrecognized principle of paleontology that the surest way to obtain such material is to photograph, describe and prepare plates on the material available. New and better material is almost sure to turn up either just after the plates have been finished or while the work is in proof. This principle will, I hope, be known as "Flower's law."

The main purpose of this paper is to illustrate and describe fossils of some diagnostic stratigraphic value. Descriptions are arranged faunally rather than systematically.

ACKNOWLEDGMENTS

As noted in the introduction I have had liberal help from various specialists, often to the point of generic identification. Among them are Dr. G. A. Cooper, Dr. Lehi Hintze, Dr. Christina Lochman Balk, Dr. Reuben Ross, Dr. Ellis Yochelson, Dr. Jean Berdan, Dr. John Pojeta, and Dr. Keith Rigby.

Many have helped in collecting. I want to acknowledge Dr. Frederick Kuellmer, Dr. Frank Kottlowski, Dr. Robert Zeller, Dr. A. K. Armstrong, and particularly Dr. David LeMone and my wife. Miss Michaele Huygen has been of great help both in collecting and in the laboratory.

Stratigraphic Summary

SIERRITE LIMESTONE

The Sierrite Limestone consists largely of thin beds of limestone, somewhat dolomitized in various sections, with fine undulate bedding, largely stylolitic. Where dolomitization is advanced, however, bedding may be obscured. The interval may range up to a hundred feet. A few feet at the base grade downward into the sandy beds of the upper Bliss Sandstone in some sections, notably in the Mud Springs and Caballos Mountains, having abundant sand and glauconite. More westerly sections show a considerable interval of dolomite in the upper Bliss, notably in the Cooks Range, Lone Mountain, and some sections in the Black Range, but there is an upper, rather soft-weathering massive 2-3′ sandstone marking the top of the Bliss. The upper boundary of the Sierrite Limestone is hard to place in the field, from seeming upward gradation into calcarenites rather than calcilutites, in beds which generally lack obtainable faunas. The Big Hatchet Mountains are anomalous in that the Sierrite is an advanced dolomite there, and its lower boundary is difficult to determine in some sections. I must, however, differ from Zeller (1965) who assigned 192′ of dolomite, with the base sandy and arkosic, to the Bliss; if this interpretation is true, there is no Sierrite limestone in the section, and it is the only one in the state in which this interval is wanting. Certainly at least the upper 50′ must be late Gasconadian in age.

Faunas are poorly preserved. Here are figured some *Apheooethis, Lytospira gyrocera,* probably the most abundant fossil of the unit, and some *Symphysurina.* Additional forms, yet represented only by very poor specimens, include some additional gastropods, including a rather large form, apparently an *Ophileta,* a very few ellesmeroceroids (Flower, 1964), some small brachiopods of the aspect of *Finkelnburgia,* some *Girvanella,* and in the upper part, some hollow tubular algae. The faunas indicate equivalence with the Gasconade in the broad sense in eastern North America, the upper half of the Lower Canadian. Our trilobites suggest equivalence with zone B of Ross and Hintze, but good evidence of the fauna of zone C has not yet been found in the El Paso Group.

BIG HATCHET FORMATION

The *Kainella* zone, the Big Hatchet formation of Flower (1964) occurs in the Mescal Canyon section of the Big Hatchet Mountains above 192′ of dolomite, somewhat sandy basally, from Zeller's measurement (1965, p. 80) which he attributed to the Bliss formation. The writer would consider this interval as equivalent to the Sierrite limestone, of late Early Canadian age. Its only fossils in the region consist of (1) linguloids from an 11′ interval, 146-157′ above the base of the Paleozoic, and a bed 172′ above the base which has yielded *Calceochiton hachitae.* This form is very close to one in the Oneota dolomite of Wisconsin, apparently the basis of *Ascoceras gibbosum* Sardesson. If these beds, at least from 146′ above the Precambrian, are not equivalent to the Sierrite limestone, this section is the only one so far known in which that interval is absent in New Mexico or the Franklin Mountains of western Texas.

The *Kainella* zone itself is divided into two parts. The lower part consists of 57′ (Zeller's measurement) consisting of 2-5′ layers of dolomite, weathering massive, between which are 1-3′ intervals of brownish-weathering dolomitic shales, dark gray when fresh. It is the shale intervals which yielded the trilobite fauna here described. Specimens are fragmentary, and the forms here illustrated and described were obtained from working a large amount of material, in which loose thoracic segments dominate all other remains. The specimens are poorly preserved, some heads are considerably crushed, but the forms are worth figuring as the first indication of the trilobites of zone D of Ross (1950) and Hintze (1951, 1952) found in the New Mexico sections. The upper part consists dominantly of massive dolomites without apparent shale, but containing abundant cherts, some of which are large, spheroidal, and white-weathering. These beds occupy a thickness of 288′. Some limestones are present, and they contain, in the Hatchet Mountains, fragmentary trilobite remains and abundant echinoderm plates, but they have yielded nothing identifiable. Beds of this position, limestones with white-weathering spheroidal cherts, in the Victorio Mountains, have yielded a poorly preserved *Kainella* pygidium. Fossils of this interval do not chop out readily, and beds at this position in the column in many sections in New Mexico have thus far failed to yield identifiable fossils. It is worth noting, however, that in the eastern sections it is at this position that the beds occur which have yielded *Apheoorthis finkelnburgiae.* Equivalence is probable, but not yet fully demonstrated.

The fauna of the Big Hatchet formation of the Big Hatchet Mountains consists of *Kainella, Leiostegium, Hystricurus,* and small brachiopods here figured as *Nanorthis?* sp. and *Apheoorthis* sp. Some small inarticulate branchiopods are not described but are not uncommon.

The writer had previously regarded the Big Hatchet formation as marking sedimentation in a period of time between the Lower and Middle Canadian generally represented by uplift and erosion over most of eastern North America. Because of the faunal contrast at its top, marked by the incursion of a large gastropod and cephalopod fauna at the horizon of the first endoceroid zone, the Big Hatchet formation was grouped with the Lower rather than with the Middle Canadian. It now seems better to consider it as the initial phase of Middle Canadian sedimentation. The trilobite genera which occur here extend higher in the column, but are not known at lower horizons. Work in the Ibex area with the help and guidance of Dr. Lehi Hintze revealed the presence of the first endoceroid zone fauna in two reefs, one at 95-100′ above the base of the Fillmore limestone, another at 185-195′ and extending up to 220′. These intervals are still in zone D, though future work may show there a slightly augmented fauna, though one still with *Leiostegium* and *Kainella.*

THE APHEOORTHIS FINKELNBURGIAE ZONE

Small silicified brachiopods occur in a thin bed, some distance below the first endoceroid zone in eastern sections of the El Paso group in New Mexico. They have been found in a thin limestone layer in the Mud Springs Mountain section; they occur silicified in dolomite in the sections in the San Andres from Rhodes Canyon to Ash Canyon, and in the southern Franklin Mountains, and they are abundant in limestone in the Hueco Mountains.

These forms occur in beds which have yielded no other fossils as yet, above the Gasconadian faunas of the Sierrite limestone, and below the Middle Canadian faunas of the Cooks formation, the first endoceroid zone. The beds occupy the position of the Big Hatchet formation, fully developed only in the Big Hatchet Mountains, but present also in the Victorio Mountains section, where spheroidal white-weathering chert and a *Kainella* have been obtained. Exact equivalence is, however, not yet fully demonstrated, though it seems a reasonable inference.

COOKS FORMATION

This interval is limestone in most of New Mexico, but a dolomite in the southern Franklin Mountains. As a limestone, it consists of calcilutites, with some nodular chert and silicous worm trails, with beds of stromatolites and pebble breccias. In general, the limestones are light gray and light weathering, in contrast to the darker and darker-weathering limestones of the Victorio formation above.

The formation is marked by the first appearance in the El Paso of endoceroids, most commonly represented by isolated endosiphuncles. They include *Clitendoceras* (=*Kirkoceras*), *Proendoceras,* and several genera as yet unnamed. With them are primitive small piloceroids and an *Aphetoceras.* The formation has yielded trilobite scraps; there is an *Evansaspis* here, evident pilomerids and hystricurids, but most fragments defy generic identification. The Cooks Range section exposes light blue-gray weathering limestones on the surfaces of which can be seen complete enrolled trilobites, 2-3″ wide, and thoracic segments 8-10″ wide, which have so far defied collecting, let alone extraction. There are small gastropods here of the aspect of *Ophileta, Ozarkina* and *Lytospira,* but specimens defy extraction and close specific comparison, but the larger *Proliospira* is abundant and characteristic.

The fauna of this zone has been recognized in the lower Manitou dolomite, in the Fillmore limestone in zone D, 190-210′ above its base, and in the upper part of the Goodwin limestone of Nevada. The fauna shows affinities with the Gorman of Texas, the Longview of the Appalachians, the Roubidoux of Missouri and the Fort Ann limestone of the Champlain Valley. There is a shallowly cup-shaped sponge, and some brachiopods including apparent *Diaphelasma* and a small ribbed form, apparently an *Archaeorthis.* The maximum thickness of this formation in New Mexico is 80′.

VICTORIO HILLS FORMATION*

This horizon, first called in my notes the second endoceroid zone, and later the first piloceroid zone, consists of calcilutites alternating with several massive layers of stromatolitic reefs with detritus in the interspaces. Here appear abundant piloceroids, including true *Piloceras* and *Bisonoceras,* with a number of undescribed genera, some slender endoceroids which are, in general, materially larger than those of the first endoceroid zone. There are sponge fragments, abundant here for the first time in the section, *Diaphelasma* cf. *complanatum,* gastropods, mostly poorly preserved, but containing an apparent small *Ophileta* and a *Proliospira;* specimens are poor, and specific comparison is not possible. Trilobite scraps have been encountered, but no generically identifiable specimens other than *Evansaspis.* There are hystricurids, pliomerids and asaphids.

At El Paso the Victorio formation is about 290′ thick, but is less than 100′ in most New Mexico sections.

The cephalopods permit recognition of this fauna in the Manitou limestone, roughly 80′ above its base, and from 320-370′ above the base of the Fillmore limestone of western Utah in zone E. No trace of this fauna has been found in Nevada.

To the east, a *Campbelloceras* suggests that the horizon may be present in the uppermost Roubidoux, in the upper part of the Fort Ann limestone, but we have not as yet found traces of the fauna elsewhere.

JOSÉ FORMATION

The José formation consists of black oolitic limestones, generally in thin layers, with some black nonoolitic limestone, some black layers with black pebbles, some beds of pinkish pebbles, believed by the writer to be algal in origin. Thickness is commonly 30-40′ though only 15′ were found in one section in the Florida Mountains. The section at the southern end of the Franklin Mountains preserves the oolitic black layers, but they are dolomitized, and the interval fails to yield fossils except for a few of the small characteristic gastropods, which were partly silicified. This section is unique in containing some layers and lenses of massive stromatolites, not observed in the sections in New Mexico. The horizon is persistent, always occurring above the Victorio formation, the first piloceroid zone, and below the *Bridgeites* reefs, the Mud Springs formation. It is conspicuous, as it weathers much darker than beds above or below.

The commonest fossil is an asaphid trilobite. Some layers are simply filled with remains of this form, consisting dominantly of pygidia and free cheeks. Cranidia are rarely preserved. This form is here described and figured as *Aulacoparia*? *huygenae,* with a somewhat different form described as *Aulacoparia*? sp. Small discoidal gastropods are present here described as *Bridgeina carinifera* and *B. rotunda.* There is a high-spired gastropod, *Hormotoma zelleri.* In addition, there is a small brachiopod of dalmanellid aspect, possibly a *Finkelnburgia,* and some small slender cephalopods, smooth shells of the aspect of tiny *Rioceras* of the Baltoceratidae, and

* This was originally named the Victorio Formation, which name, I am informed, is preoccupied.

annulated shells of the genus *Kyminoceras* of the Protocycloceratidae, which are not yet described, the present available material being sadly fragmentary.

Additional trilobites include an *Oculomagnus, Leiostegium* cf. *manitouense,* and a pygidium similar to one reported from zone E by Hintze (1952).

Precise correlation of this horizon presents some problems. The underlying Victorio Hills formation cephalopod fauna has been found in zone E of Hintze in the Ibex region, from 320′ up to 360′ above the base of the Fillmore limestone. Some considerations would suggest equivalence of the José formation with high E, while others would suggest a higher horizon. Lochman (1966) described a fauna from the Arenig rocks of the Williston Basin which has in it some things similar to the José fauna, which she correlated with zone G. This fauna contains *Oculomagnus* not unlike ours, an *Aulacoparia* which is similar, a small *Finkelnburgia,* but the gastropods are not similar.

The writer would be inclined to believe that the José formation correlates with high E or F of the Ibex region, rather than G or higher beds, and that it is, from the continuation of *Leiostegium* through it into even higher beds, late Middle Canadian rather than Jeffersonian. Jeffersonian age is suggested instead for the faunas of the McKelligon formation which may attain a thickness of about 675′ in the southern Franklin Mountains, and occurs above the Snake Hills formation in sections of New Mexico.

MUD SPRINGS FORMATION

Succeeding the dark oolitic limestones of the José formation is the Mud Springs formation, consisting of 20-30′ of light-weathering stromatolitic limestone, resistant, generally cliff-forming, with chert largely in small nodules and silicified worm trails. We found only 12′ in the Florida Mountains, and the formation is wanting in the southern Franklin Mountains. Only one fossil is abundant there, a discoidal gastropod, commonly 1½″ across, here described as *Bridgeites discoideus.* The interval contains rare sponges and cephalopods, generally seen where they could not be obtained. The type of *Dartonoceras gracile* came from this interval.

Our scant faunal information thus far fails to indicate any precise correlation of this horizon either to the east or to the west.

SNAKE HILLS FORMATION

Succeeding the stomatolitic cliff-forming Mud Springs formation, are thin beds, commonly of calcilutites, relatively chert-free, which contain a considerable fauna of small fossils, most of which defy extraction in identifiable conditions. Some calcilutites are filled with tiny gastropods, ranging from high to low-spired. *Lloydia (Leiostegium)* sp. is the only form from this interval figured at the present time. Other genera are present, including *Presbynileus.*

From the *Leiostegium,* this interval is considered the youngest of the units of the El Paso of Middle Canadian age. Evidence is lacking which would suggest equivalents in Canadian sections either to the east or to the west. The maximum observed thickness of this formation, 60′, is found in the Cooks Range.

McKELLIGON FORMATION

The McKelligon formation consists of a great thickness of calcilutite—Cloud and Barnes' measurement approximates 675′ on the southern Franklin Mountains—with, at the base, the Pistol Range Member, of some 30′ of dolomite and sand at the very base. The limestones contain several intervals of massive stromatolitic reefs, with abundant sponges and piloceroids. Other faunal elements are present, but not generally extractable in an identifiable condition, including gastropods, trilobites and brachiopods. The lower limestones have, however, yielded *Ceratopea* of Jefferson City aspect. I had at first thought that the higher reefs might contain equivalents of the Cotter and Powell formations of east-central North America; they show some faunal differentiation from the lower two-thirds of the limestone. Subsequent work, however, has revealed a fauna of unquestionable Cotter affinities in the lower part of the Scenic Drive formation. The McKelligon formation therefore appears to be equivalent to the Jefferson City group of the east. Its precise equivalents in the Utah sections is a matter on which evidence is still ambiguous, though at the very most, its equivalents must lie within zones F, G and H, though I believe H to be Cassinian.

SCENIC DRIVE FORMATION

The Scenic Drive formation consists of essentially unit B2b of Cloud and Barnes (1948). The upper part consists of 226′ of limestones, largely thin beds of calcilutite. A little below the middle, a black bed has yielded some significant gastropods here described, and just below this is a readily recognizable layer of calcarenite with partially silicified cores of sponges. There is some indication of more than one fauna in the limestones, but while *Hesperonomia* and *Pseudocybele* have been found only in the upper third of the limestones, the yield from the lower beds is yet very meagre.

Underlying the limestones are dolomites, the upper beds with only minor sand, the lower beds with abundant sand. The top 12′ contain silicified fossils; here are *Ceratopea hami* and *C. buttsi* in association, not, as one might expect, in succession. The bed contains some gastropods, a few pelecypods, some cephalopods, including *Tarphyceras* to be published elsewhere, and species of *Rioceras* and *Cyptendoceras* previously described (Flower, 1964) and a poorly preserved large bivalved crustacean. *Ceratopea* is common, and is generally well silicified.

Some 37′ lower in the section a single lens has yielded a fauna with *Ceratopea ankylosa,* a variety of gastropods, the pelecypod genus *Euchasma,* a few cephalopods, including *Arkoceras, Clelandoceras, Avaoceras,* and poorly preserved Endoceratida, Baltoceratidae and Protocycloceratidae, poorly preserved, ostracodes (this marks the lowest observed position of this group in the section), trilobite fragments, and some remarkable merostomes. Brachiopods are few, and poorly preserved. The base of the unit is a conspicuously sandy bed in dolomite some 45′ lower in the section.

FLORIDA MOUNTAINS FORMATION*

The highest El Paso is the Florida formation, about 35′ thick in the Florida Mountains and also in the southern Franklin Mountains. It contains beds of calcarenites in both sections; interspersed with calcilutites in the Florida Mountains, but with abundant orange-weathering silts in the Franklin Mountains. The fauna is a large one, and our knowledge of it will shortly be greatly increased, thanks to extensive collections made by Dr. David LeMone from the southern Franklin Mountains, which greatly augment earlier collections made there and in the Florida Mountains by the writer. Brachiopods include small forms, apparently *Diparalasma,* and larger more conspicuous forms of the genera *Hesperonomia, Tritoechia* and *Syntrophopsis*; the last two genera are not known in underlying beds. A good lot of trilobites has been retrieved; genera are those of zone J, but the species are largely distinct from those of Utah. We can cite with certainty *Pseudocybele, Goniotelina, Pseudomera,* apparent *Bolbocephalus* and *Peltabella,* and asaphids, possibly *Kirkella* and *Isoteloides.* Gastropods include a small "*Maclurites*" and an operculum of the aspect of "*Maclurites*" *odenvillensis, Hormotoma* and some bellerophontids. Pelecypods have not been found. Cephalopods include *Buttsoceras, Michelinoceras,* small Baltoceratidae and Protocycloceratidae. Fragments of Tarphyceratida have been found. The Endoceratida are remarkable in their absence. The formation has yielded some other remarkable fossils including some small crinoids and cystids; Dr. G. A. Cooper obtained there (personal communication) a good fragment of a starfish.

The Florida Mountain section has yielded a large bivalved crustacean which we have not found in the section at El Paso. It is hoped that the fauna of the Florida formation on which work is considerably advanced, will be published separately.

The fauna equates with that of zone J of Utah in the Wahwah limestone. Zone K, which is most sparsely fossiliferous, and seems from current collecting to have much in common with zone J, is probably not represented, purely on the basis of thickness, for the Florida formation is less than a fourth the thickness of zone J alone in the Utah sections.

To the east, the brachiopod types and the *Buttsoceras* suggest that equivalents are to be found in the highest Arbuckle limestone (Dr. Ellis Yochelson collected a *Buttsoceras* there in association with *Ceratopea unguis*) in the Odenville of Alabama, and less certainly, with the Black Rock of Arkansas and the Providence Island limestone of the Champlain Valley, to which we may add as a guess, the Corey and Basswood Creek limestones of the Phillipsburg region of Quebec.

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* This was originally proposed as the Florida Formation (Flower 1969). That name is preoccupied.

Descriptions

I SIERRITE LIMESTONE

Lytospira gyrocera (Roemer)
Pl. 1, fig. 32

This is a moderately slender gastropod with a loose free coil, describing ordinarily one and a quarter volutions. The type material consists of specimens weathered on limestone surfaces, and fails to supply information on the surface markings or cross section. While admittedly this species may be too broadly defined, and is certainly poorly known, it is unique in shape and turns up invariably in limestones of Lower Canadian age.

The type material is from the San Saba Valley, clearly from the Ellenberger limestone. I have encountered it in the Threadgill limestone member of the Ellenberger formation in exposures at Threadgill Creek. The specimens here figured are from the Lower Canadian Sierrite limestone of the El Paso group, from Mud Springs Mountain. The Sierrite limestone is only sparsely fossiliferous, and this fossil is the only form distinctive of this horizon that is at all commonly seen on weathered surfaces. I have observed it in the section at Sly Gap, at Cable Canyon, and in the Cooks Range. All species occur in thin limestones with wavy, somewhat stromatolitic bedding, and are most poorly preserved. Possible traces of this same species in a more dolomitic facies of these same beds, have been observed at Rhodes Canyon and in the southern Franklin Mountains at El Paso.

Cloud and Barnes (1946, pl. 40, fig. 27) have illustrated this form from the Threadgill member of the Tanyard formation. Sando (1957, pl. 11, fig. 20-22) has illustrated it from the Stonehenge limestone of Maryland. I have not found it in the Gasconade beds at Fort Ann, but Cleland (1900, pl. 15, fig. 1) has figured and described as *Ecculiomphalis multiseptarius* a shell of similar form and proportions, but one showing abundant diaphragms within it, in the Tribes Hill limestone of the Mohawk Valley.

Figured specimen.—NMBM no. 1295 from the lower 40′ in the El Paso group, above the Bliss sandstone, Mud Springs Mountain, New Mexico.

Symphysurina cf. *brevispicata* Hintze
Pl. 1, fig. 25-28, Pl. 2, fig. 21, 22

Thin beds of slightly dolomitic limestone in the Sierrite formation have yielded poorly preserved Symphysurina 20-30′ above the top of the Bliss sandstone in the Cooks Range. The heads show some variation in convexity, which may be partial crushing of some of the specimens (see Pl. 1, fig. 26, 28), but in outline are quite like Hintze's (1952, pl. 3, fig. 14) figure of *S. brevispicata.* The pygidium (Pl. 2, fig. 21) has also the aspect of that species. It is reassuring to find in this form evidence suggesting equivalence of the lower Sierrite limestone with zone B. Zone A of Ross presumably has its equivalents in the upper Bliss, which has yielded *Symphysurina* at several localities. I am indebted to Dr. Lehi Hintze for the specific reference of this form.

Figured specimens.—Nos. 1231, 1232, 1234, 1238, from 20-30′ above the base of the El Paso group, Cooks Range, New Mexico.

Apheoorthis sp.
Pl. 1, fig. 29-31

Apheoorthis is represented by specimens in the upper, early Gasconade part of the Bliss sandstone. These forms seem allied to several described species, notably *A. melita* of the Goodwin limestone, *A meeki, lineocostata* and *bella* of the Manitou limestone, and to *A. ochoa* and *A. vicina* of the Mons formation, without being identical with any of them. These forms, which will be described and illustrated with other faunal elements of the Bliss sandstone, may possibly be a species distinct from all of these forms. The genus is uncommon in the Sierrite limestone, but an association was obtained from a thin bed of calcarenite 15-25′ above the top of the Bliss sandstone in the Cooks Range. The specimens seem similar in general to the forms from the upper Bliss, but average somewhat smaller in size, and show some variation in surface markings, as well as in proportions. In both respects, the Sierrite specimens seem to come somewhat closer in general aspect to *A. lineocostata* than do the Bliss forms.

Figured specimens.—Nos. 1239-1241, from 10-15′ above the base of the Sierrite limestone, Cooks Range, New Mexico.

II EARLY PALEOZOIC (= SIERRITE?) OF THE HATCHET MOUNTAINS

CALCEOCHITON Flower, n. gen.

Genotype: *Calceochiton hachitae*

This chiton, known only from isolated plates, is characterized by the form of the plates, which are narrow, elongate, sharply pointed posteriorly, the top convex, arched, rarely subangular on the median line. In side view the top may be straight, slightly concave or slightly convex. Below, the interior may be subacute along the axis, or rounded, the wall tends to thicken apically and may partially enclose a narrow apical space on the venter.

Discussion.—This genus is characterized by its narrow form, pointed apex, and for the tendency for partial enclosure of a small apical space. Plates assigned to *Chelodes* are more rounded in outline and form, and have more rounded lateral outlines.

The genotype, which came to my attention some 12 years ago, is from the lower El Paso of the Hatchet Mountains. A related form, larger, showing consistently growth lines and a more concave anterior margin, is from the Oneota dolomite of Wisconsin, and is presumably the form which Sardesson described as *Ascoceras gibberosum.*

Spelman (1966, p. 100-102, pl. 20) has figured a variety of amphineuran plates from the Lower Canadian Stonehenge limestone of Pennsylvania. Of these, his type IV, shown in

figures 19-25 and possibly type II, shown in figures 13-15, appear to belong to *Calceochiton.*

Calceochiton hachitae Flower, n. sp.
Pl. 1, fig. 1-9

Plates of this form are without observed growth lines. The tip, generally wanting, has the shell growing over the under side enclosing a small cavity below, and is, from indications of the various specimens, quite strongly pointed. The various shells show considerable variation in convexity and the nature of the cross section. Pl. 1, fig. 1-3 shows a strongly convex specimen, the interior of which shows a medium longitudinal concave angle. The most gently rounded form is shown in Pl. 1, fig. 7-9. The anterior margins of the plates, rarely perfect, are slightly concave.

Discussion.—These plates show some variation in proportion, but our greatest length is 11 mm, the greatest width 6 mm. They are smooth externally, thicken apically and close around the under surface, and are concave anteriorly.

Syntypes.—Nos. 1264-1266; additional unfigured specimens through 1268. All from 172′ above the Precambrian, in dolomites regarded as the equivalent of the Sierrite limestone, Mescal Canyon, Big Hatchet Mountains.

Calceochiton cf. *gibberosum* (Sardesson)
Pl. 1, 10-24

These chiton plates from the Oneota show some variation in proportions, illustrated in our Pl. 1, fig. 10-24, but show rounded dorsal surfaces in cross section, nearly straight sides, gently converging apically, and concave anterior margins. Rate of expansion varies from the broad form shown in fig. 10, to the slender one in fig. 18; in profile some plates are convex dorsally, others are straight, while fig. 17 shows a shell that is slightly concave.

Discussion.—This is allied to the preceding form, but is larger, shows better growth lines, the shell shows less apical thickening, and we have no specimens in which the ventral cavity is surely enclosed below. These forms are figured here as examples of a relative of *C. hachitae,* in the Oneota dolomite of Gasconade age. Further work may show more than one species in this association and may be the explanation of the wide variation in profile and rate of expansion.

Figured specimens.—nos. 1269-1274. from the Oneota dolomite, near Sauk, City, Wisconsin.

Ectenoglossa? sp.
Pl. 2, fig. 23

The top 10′ of the Bliss sandstone on the west side of the Hatchet Mountains yielded a single tiny very slender linguloid of the form of *Ectenoglossa.* The tip of the beak is missing, the shell is 5.2 mm long, 2 mm wide, and was probably 6 mm or more in length when complete; the surface shows fine radial costellae.

Figured specimen.—No. 1280, from 146-157′ above the base of the Paleozoic, Mescal Canyon, Big Hatchet Mountains, New Mexico.

Broeggeria (?) sp.
Pl. 2, fig. 24

Of this form we have a single ventral valve, 7 mm long, 8 mm wide, showing a very thin shell with two or three prominent distant concentric markings. Assignment to *Broeggeria* rather than to *Elkania* is suggested by the apparently only slight thickening of the shell at the beak. Both genera range from Upper Canadian into at least the Lower Canadian.

Figured specimen.—No. 1276, from 146-157′ above the base of the Paleozoic, Mescal Canyon, Big Hatchet Mountains, New Mexico.

Undetermined linguloids
Pl. 2, fig. 25-27.

The lowest fossils of the El Paso of the Mescal Canyon section of the Hatchet Mountains consist of rather nondescript linguloids, associated with the preceding form. Pl. 2, fig. 25 (no. 1277) is a shell 9 mm long and 7 mm wide. The surface shows very fine irregular concentric markings with occasional rather regularly spaced stronger, more regular concentric elevations. Exfoliation shows faint costellae on an inner layer of the shell. This form could easily be a *Lingulella.*

A second form, shown in fig. 26, is a tiny shell (no. 1275), almost smooth, 4 mm long and 3 mm wide.

A third tiny specimen shown in Pl. 2, fig. 27, has the tip of the beak missing, is 4.2 mm wide and 5 mm long, probably 5.5 mm with the beak completed. It shows faint concentric markings but is nearly smooth near the beak, distally radial costellae are evident.

Figured specimens.—Nos. 1275-1278, from 146-157′ above the base of the Paleozoic, Mescal Canyon, Big Hatchet Mountains.

III BIG HATCHET FORMATION

Kainella sp.
Pl. 2, fig. 1, 7, 11, 12, 14, 15, 19, 20.

Though oddly, a *Kainella* tail was one of the first fossils retrieved from the *Kainella* beds of the Hatchets, the subsequent finds have proved fragmentary, and poorly preserved. Most heads are badly crushed, and serve as a poor basis for identification at the specific level. Our form shows a subquadrate glabella, more like that of *Kainella meridionalis* Kobayashi from Argentina, than any other described species, but our form shows a broader and more strongly elevated brim, and a shorter distance between the brim and the anterior end of the glabella. In this respect, our form is more like *Kainella conica* Kobayashi, but in that species the anterior end of the glabella is quite smoothly rounded. The pygidia are quite incomplete, there are none showing the complete number of axial segments, but the form of the axis and of the lateral segments is quite like that of both *K. billingsi* Walcott and *K. meridionalis* Kobayashi. This form is almost certainly a new species, but the material now at hand is not considered adequate for the proper definition of a new species.

Figured specimens.—Nos. 1283-1285, 1288-1291. All from the *Kainella* zone of the Mescal Canyon section, Big Hatchet Mountains, New Mexico.

Lloydia (Leiostegium) sp.
Pl. 2, fig. 2-4, 6(?), 13.

The *Kainella* beds have yielded several pygidia of the aspect of *Leiostegium* in the restricted sense, in contrast to *Evensaspis,* or *Perischodory,* and unlike *Manitouella;* they possess a good marginal furrow and border. No certainly identifiable heads have been obtained, though one tiny head is tentatively assigned to this genus (Pl. 2, fig. 6). Two sides of a crushed pygidium are shown in Pl. 2, fig. 3 and 4, and an uncrushed pygidium, rather poorly preserved as to details, is shown in Pl. 2, fig. 13. An impression of a pygidium, to which are attached traces of seven thoracic segments, is shown in Pl. 2, fig. 2.

Figured specimens.—Nos. 1282, 1286, 1292, 1296. All from the *Kainella* beds of the Big Hatchet Mountains.

Hystricurus? sp.
Pl. 2, fig. 5.

A single head of the aspect of *Hystricurus* has been found in the *Kainella-Leiostegium* beds, and is here illustrated. It is unusual in that pustules are not developed, and in this respect recalls *Hystricurus* sp (Hintze, pl. 6, fig. 15, 16), a species of zone E, but our form has a somewhat smaller glabella and a narrower occipital ring.

Hystricurus has a considerable vertical range, from zone B through zone G-2, in spite of refinement of the genus by the recognition of *Amblycranium, Hillyardina, Pachycranium, Parahystricurus, Psalikilopsis,* and *Psalikilus* (Ross 1951). It may be noted also that our present form has somewhat the aspect of two species which Hintze (1952) referred to *Paraplethopeltis* with doubt, both of which came from zone C, but our form is not strictly like either of these in detailed proportions. Hintze (1952) lists a *Hystricurus* from zone D, but the specimen has not yet been figured.

Figured specimen.—No. 1281, from the *Kainella* beds of the Big Hatchet Mountains.

Nanorthis? sp.
Pl. 2, fig. 8, 9, 16-18

This is a small multicostellate shell of dalmanellid aspect, represented only by a few poor specimens. Without clear knowledge of the internal structure, the generic assignment is of course dubious, but these shells show the curving costellae, and addition of minor costellae as growth proceeds, which are particularly characteristic of this genus, as well shown by *Nanorthis hamburgensis* (Walcott) of the Manitou formation of Colorado. Shells of this aspect have not been as yet encountered higher in the sections of the El Paso group.

Figured specimens.—1293, 1294, 1297. All from the *Kainella* beds of the Mescal Canyon section of the Big Hatchet Mountains.

Apheoorthis? sp.
Pl. 2, fig. 10

The *Kainella beds* of the Big Hatchet Mountains has yielded a single ventral valve of a rather remarkable brachiopod of the aspect of *Apheoorthis.* This specimen, 8 mm long and 14 mm wide, is apparently an internal mold. It shows six folds which are strong basally, the spaces smooth between. Distally, additional ridges develop, four in the median area, three between the next two pairs of ridges, two between the next pair. Ornamentation in the extreme lateral areas is obscure. Forms with such prominent radial ridges, which must have been actually costae or shallow folds, include *A. ochoa* of the Mons formation and *A. bella* and *A. meeki* of the Manitou limestone. None seem identical with our form in general aspect, even allowing for the possibility that the abrupt appearance of secondary costellae might be a feature of the interior, and not the exterior, the result of internal thickening of the central part of the shell.

Figured specimen.—No. 1298, from the *Kainella* beds, Mescal Canyon, Big Hatchet Mountains, New Mexico.

IV APHEOORTHIS FINKELNBURGIAE ZONE

Apheoorthis finkelnburgiae Flower, n. sp.
Pl. 3, fig. 1-13

This is a small brachiopod, biconvex, shells rarely larger than 12 mm in width and 10 mm in length. The internal features are those of *Apheoorthis,* but differs from all other species of that genus in that the surface bears fine subequal costellae. The closest species to this previously known is *A. meeki* of the Manitou limestone, but even there, there is a fasciculate grouping of costellae, though the prominent plications of *A. melita* or *A. ornata* are not attained.

Discussion.—As a shell with the interior of *Apheoorthis* but a surface more typical of *Finkelnburgia,* this species could conceivably be made the basis of a new genus, which would serve no other purpose than to restrict *Apheoorthis* to shells with from fasciculate costellae to strongly plicate surfaces.

The species occurs widely in the eastern outcrops of the El Paso limestone. From the Franklin Mountains to Rhodes Canyon in the San Andres Mountains, it occupies bedding planes in a 2-4′ interval, and silicified shells are readily seen where the matrix is a dolomite. This condition is general, but not universal. In Ash Canyon shells of this aspect occur in limestone at this horizon but are not properly identifiable. Indeed, this is the lowest fossil in the El Paso generally discernible on weathered surfaces. At El Paso, the form occurs 71′ above the base of the El Paso; at Rhode Canyon, it is found 85′ above the base of the Paleozoic, the lowest 46′ of which are assigned to the Bliss Sandstone.

The species has been found again at Mud Springs Mountain; in the Hueco Mountains, it forms a shell coquina of about 15′ lying roughly 40′ above the Bliss and 30′ below the fauna of the first endoceroid zone.

The generic assignment to *Apheoorthis* is not mine but rather the work of Dr. G. A. Cooper, whom I had hoped would describe this species, having supplied the essential information as to its generic affinities.

Types.—Syntypes no. 1185-1190, from the El Paso of the southern Franklin Mountains. Additional unfigured syntypes from that locality are no. 1191 and others from Rhodes Canyon, no. 1192.

V COOKS FORMATION

GENUS *PROLIOSPIRA* Flower, n. gen.

Genotype: *Proliospira lenticularis* Flower, n, sp.

This is a broad, low, lenticular shell, the upper surface of about three whorls, nearly smooth above, with the sutures only faintly incised, the outer angle acute, the whorl much broader than high, resembling *Liospira* in general, except for the widely phaneromphalous umbilicus. The upper surface of the shell is nearly smooth, the tops of the whorls forming a simple, smooth, slightly arched surface except for the faint sutures. In cross section, the whorl shows a very faintly convex upper surface sloping gently downward from the suture to the outer angle, which is probably marked by a slit or notch, not clearly evident from our material, which lacks clear growth lines. Below the angle, the whorl slopes strongly inward, the convexity, at first slight, increasing rather rapidly at the umbilical region; within and above this point, the whorl is concave and slopes strongly outward along the parietal region to receive the under surface of the preceding whorl, terminating at an obtuse angle at the dorsal suture.

Discussion.—This genus is erected for shells that resemble *Liospira* in general, differing mainly in that the umbilicus is widely phaneromphalous. These shells have been found to be particularly characteristic of the Demingian portion of the El Paso group, and similar if not identical forms have been seen from equivalent positions in the Manitou limestone of Colorado and in the Fillmore limestone of western Utah, associated with the fauna of the first endoceroid zone. Similar and perhaps identical forms occur in the El Paso group in the first piloceroid zone, but the genus is not known to extend higher in the section.

Pararaphistoma Vostakova is comparable, and Dr. Ellis Yochelson has kindly loaned specimens of the genotype, *Helicites qualteriatus* Schlotheim, for comparison. While it is not impossible that future work may show *Proliospira* to intergrade with *Pararaphistoma,* the forms seem now distinct. *Pararaphistoma* is a shell much higher in proportion to its width, with the lower part of the outer whorl less inclined inward and less flattened below the outer angle, the umbilicus less widely open. Oddly, while *Proliospira* is Demingian in age, specimens of *Pararaphistoma* known to me in North America are Cassinian, and thus materially younger. One is *P. lemonei* from the Scenic Drive formation of the El Paso group, and a smaller form, though one remarkably similar in proportions, I have collected from the Wahwah limestone of western Utah. The genotype is from the *Vaginatum* limestone of Esthonia, in which some faunal elements suggest early Whiterock rather than Canadian age.

Our specimens of *Proliospira* show a general absence of initial whorls. I believe this to be due to diaphragms in the apex, which leave the earliest whorls calcite-filled; such calcite is generally removed with the matrix and shell wall. Similar diaphragms are present in true *Pararaphistoma.*

Raphistoma sinclairensis Kobayashi (1955) is quite certainly a member of the genus *Proliospira.* The holotype shows a shell somewhat more gently enlarging than that of *lenticulare,* and with a somewhat flatter spire. The paratype, however, shows a rate of enlargement quite like that of our species, *R. sinclairensis acuta* is less clearly comparable, largely because the figure is poor, but the ramp seems to widen more rapidly, and the spire seems more elevated. It is of interest to note that both of these forms are attributed to the "*Kainella-Evansaspis* fauna" which is reasonably zone D of western Utah, and it is within the upper half of zone D that the fauna of the first endoceroid zone is found. Lochman (1965) has recognized Kobayashi's species in zone D faunas of the Williston Basin. This is consoling, though the identification is an act of faith.

Proliospira lenticularis Flower, n, sp.

Pl. 3, fig. 14-25.

This species has the characters of the genus. Our types are largely internal molds and show some slight elevation of the penultimate whorl beyond the last, which is possibly the result of increased adoral thickness of the shell. The form is best shown by the illustrations. The largest shell shows three whorls, though there may be a little more, the apical part being poorly preserved, 35 mm wide, 11 mm high, with a whorl 15 mm wide and 8 mm high, the parietal portion 4 mm wide. A second specimen, 31 mm wide and 9 mm high, shows an outer whorl 14 mm wide, with 3 mm in the parietal portion, 6.5 mm high. A third specimen, 30 mm wide and 9 mm high, shows the outer whorl 15 mm wide, 4 mm in the parietal zone, and 9 mm high.

Discussion.—Though generally hard to extract and poorly preserved as to surface, this is a common and characteristic form of the first endoceroid zone of the El Paso group, the Cooks formation; it possibly continues into the first piloceroid zone, where there are forms of similar aspect, but no specimens have been obtained there that are clearly enough extractable for proper study. The same or a closely similar form has been collected in the upper part of zone D of the Fillmore limestone, roughly from 95 to 105′ above the base of the formation, and has been seen in material apparently also from the first endoceroid zone in the lower part of the light gray to yellow limestones in the lower part of the Manitou limestone of Colorado.

Our several specimens all show the initial whorls obscurely. In *Pararaphistoma,* a similar condition exists, the cause being a series of initial diaphragms in the early part of the shell. Ordinarily, the shell section traversed by diaphragms is calcite-filled and tends to come away from the specimen with the calcite of the shell and matrix. A similar condition would explain the preservation of *Proliospira lenticularis.*

Types.—Four syntypes, nos. 1196-1199, from the first endoceroid zone, Cooks formation, of the El Paso group. Our types are from the Cooks Range, New Mexico, but the species has been observed in Rhodes Canyon, in the Hatchet Mountains, the Mud Springs Mountain, Mimbres Valley, and various sections in the Black Range and seems quite widespread, even though specimens which will separate readily from the matrix are rare.

VI JOSÉ FORMATION

Aulacoparia? huygenae Flower, n. sp.

Pl. 4, fig. 18, 20-27, 29.

We have of this species a number of crandidia, free cheeks, and pygidia. The pattern of the facial sutures is best shown by

our illustrations. Widening in front of the palpebral lobes is less marked than in most related species, the palpebral lobes are somewhat less convex, and located scarcely behind mid-length of the crandidium. The glabella, though indistinctly outlined, is convex, with a vestigial median ridge, and obscure segmentation apparent more internally than externally. The preglabellar field, concave before the glabella, and becoming faintly convex anteriorly, is nearly half the length of the glabella. Posterior limbs have oblique anterior margins, narrowing laterally; a shallow occipital ring and furrow, continuing as border and furrow on the fixed cheeks; both are narrow and of slight relief. The mature pygidium has an axis with indistinct segmentation, both externally and internally, narrows posteriorly to a little more than half the anterior width, and is then bluntly rounded, the apex being raised into an obscure tubercle. Segmentation is too obscure for accurate counting of the segments, which were probably ten in number. Pleural fields show one pair of anterior pleural furrows well preserved, but other segments are obscure even on the interiors, and are only most faintly indicated externally. A concave border furrow limits the pleural fields distally, merging into a low only faintly raised border. The posterior margin is convex, neither pointed nor emarginate. The posterior margin of the axis reaches nearly to the border furrow.

An immature pygidium (Pl. 4, fig. 20), shows both pleural and interpleural furrows, as well as axial furrows; there appear to be ten segments, though the posterior ones are somewhat obscure.

A small pygidium from the Mimbres Valley section has attached to it eight thoracic segments, shown in Pl. 4, fig. 22.

Discussion.—This form is here described and illustrated as the commonest and most conspicuous fossil of the José formation of the El Paso group. The generic assignment was suggested by Dr. Lehi Hintze and Dr. C. Lochman Balk. Subgeneric assignment presents some problems, as this form differs slightly from both the subgenera *Aulacoparia* and *Aulacoparina,* particularly in the posterior margin of the pygidium, in the somewhat more extended posterior lobes of the free cheeks, the slightly more anterior position of the palpebral lobes on the cranidium, and the course of the facial suture anterior to the palpebral lobes. *Aulacoparia quadrata* has the posterior margin of the pygidium notched, the axis is conical, broader anteriorly, the margin is less distinct from the pleural fields. The cranidium shows larger palpebral lobes, is broadly expanded and gently convex over a longer distance anterior to the palpebral lobes, the pre-glabellar field is shorter in proportion to the glabella. *A. venta* is somewhat more similar in the course of the facial sutures, but the cranidium expands more in front of the palpebral lobes, and the palpebral lobes are more convex. The anterior margin of the glabella is more clearly defined. The glabella has a broader, more clearly segmented axis, narrowing conically, but has a narrower and less distinct margin; the axis nearly reaches the notched posterior margin. *A. impressa* Lochman is more similar to our form in the general outline of the facial sutures, but has an appreciably occipital region. The pygidium has a rounded posterior border, but the axis extends nearly to the posterior margin, is proportionately broader than in our form, and shows no vestige of a tubercle at its tip. *Aulacoparia (Precoparia) wibauxensis* Lochman is less similar, having a longer glabella, a very short preglabellar concave area, a narrow and more prominent anterior ridge. The pygidium is more transverse in its posterior margin, the axis narrows posteriorly more rapidly.

So closely have asaphid genera been divided, that some mention should be made also of a few others as possible receptacles of this species. *Asaphellus* has a longer glabella, the posterior lobes of the fixed cheeks are longer horizontally and shorter longitudinally. The pygidium is similar, but the axial lobe is shorter. *Isoteloides* has a somewhat similar pygidium, but the glabella is wider, less widenend anterior to the palpebral lobes, and has a low broader convex anterior brim. Glabellar proportions are not closely similar to those of our species. *Doleraspis* has longer and more strongly rounded palpebral lobes, *Kayseraspis* has longer posterior limbs of the fixed cheeks, and a glabella less widened anteriorly. Other asaphid genera are less similar to our present forms in general aspect.

Types and occurrence.—Holotype, no. 1263, paratypes 1243, 1245-1248, 1262, 1230 José formation, Cooks Range, Mimbres Valley and Big Hatchet Mountains, New Mexico.

Aulacoparia? sp.

Pl. 4, fig. 19, 28

Two of the asaphid specimens here figured differ slightly from the main lot, and may be one or two distinct species. The cranidium shown on Pl. 4, fig. 19, shows a proportionately longer glabella and shorter preglabellar area which is between a third and a fourth the length of the glabella; the concave part is materially shorter than in *A. huygenae*. The posterior border and furrow are less distinct and apparently narrower. Palpebral lobes are slightly more anterior in position. The pygidium shown on Pl. 4, fig. 28 is smoother than average, the anterior pleural furrows are only faintly indicated, the tip of the axis is broader and less definitely tuberculate, the border furrow and border are broader and more sharply set off from the pleural fields than in *A. huygenae*.

Figured specimens.—Nos. 1244, 1242. José formation, El Paso Group, Cooks Range and Mimbres Valley sections.

LLOYDIA AND ITS SUBGENERA

Berg and Ross (1959) have discussed the subgenera of *Leiostegium* and Lochman (1964, 1965) has presented further clarification of the problem. It appears that *Leiostegium*, which has become rather widely known as a zone marker of zone D, is properly a subgenus of *Lloydia*, with other subgenera including *Evansaspis* Kobayashi, *Perischodory* Raymond and *Manitouella* Berg and Ross. *Lloydia (Lloydia)* seems to be recognized only in eastern North America, though as Lochman notes, subsequent work may show the subgenus *Leiostegium* to be insufficiently distinct to merit its recognition. No specimens of the aspect of *Lloydia* as at present defined in the strict sense, have been noted in western North America.

Specimens from the Snake Hills formation seem ambiguous. Pygidia are of the aspect of *Leiostegium*, but the cranidia approach without quite attaining the narrow low brim of *Manitouella;* differing in that the brim is still distinctly raised.

Leiostegium has proved something of a vexation in the El Paso group because the subgenus seems to range through

quite an interval of the beds, appearing in the Big Hatchet formation with *Kainella,* and continuing into the first endoceroid zone, the first piloceroid zone, the oolite, and reappearing in the Snake Hills formation. Specimens are not easily obtained, and are mostly rather poorly preserved. The writer was troubled at first as the genus was variously considered as "Tremadoc" and as "Lower Canadian." More recent work shows that *Leiostegium* makes its first appearance with *Kainella* in beds reasonably considered as earliest Middle Canadian, beds which possibly are without equivalents in eastern North America, but are represented in Utah in zone D, and present in the upper part of the Goodwin limestone of Nevada, which contains a Gasconadian fauna in its lower part, but extends upward to the fauna of the first endoceroid zone, which occupies the upper two thirds of zone D in western Utah.

Specimens from the first endoceroid zone, not figured at this time, are few and poor, but a series of tails show the presence there of the subgenus *Evansaspis.* Poor tails of *Evansaspis* have been obtained also from the first piloceroid zone, though only in the southern Franklin Mountains as yet. The José *Leiostegium* appears to be either true *L. manitouensis* or an undescribed and closely allied species. The Mud Springs Mountain specimens seem yet ambiguous; cranidia approach the subgenus *Manitouella* in aspect, but associated pygidia are of the aspect of *Leiostegium,* rather than of *Manitouella,* which lacks a good border, and differences in the cranidia are also apparent.

Lloydia (Leiostegium) cf. *manitouensis* Walcott
Pl. 4, fig. 3, 4.

Species of *Leiostegium* in the José formation are very similar to *L. manitouense* as refigured and redescribed by Berg and Ross (1959). Our cranidium shows a well-raised anterior border, narrowed where the glabella projects forward upon it; glabella rounded in front, sides slightly divergent posteriorly and slightly divergent, a good deep occipital furrow, with a ring slightly narrower than the furrow. Fixed cheeks show a palpebral lobe slightly crescentic, tilted outward posteriorly. The specimen is 8 mm long and 11 mm wide. The associated pygidium has much the aspect of Berg and Ross (1959) Pl. 21, fig. 17, being rounded posteriorly, with a good border, rather than the more pointed pygidium shown in their Pl. 21, fig. 12. It is 14 mm wide and 11 mm long; the axial lobe narrows from 6 to 4 mm before the rounded tip, and is 7 mm long.

Figured specimens: Nos. 1259, 1260; both from the José formation of the Cooks Range.

Oculomagnus sp.
Pl. 4, fig. 6

A cranidium of this genus is 6 mm long, 5.6 mm wide, with a large smooth convex glabella, showing a very faint axial ridge, a preglabellar field short, steeply inclined, a narrow shallow furrow and border. The palpebral lobes are crescentic, more than half the length of the glabella. The posterior lobes of the free cheeks are incomplete, but evidently narrow, with the occipital furrow and ring narrow.

Discussion.—Our single cranidium is too incomplete for close specific comparison, but resembles in general *O. obreptus* Lochman 1966, the genotype.

Figured specimen.—No. 1249, José formation, Cooks Range, New Mexico.

Undetermined pygidium
Pl. 4, fig. 17

Unidentified pygidium Hintze, 1952. Utah Geol. Min Surv., Bull. 48, pl. 8, fig. 12

A pygidium from the oolite seems identical with or very close to an unidentified pygidium figured by Hintze from Zone E of the Fillmore limestone of the Ibex region of Utah. Our pygidium is 7 mm wide, 3 mm long, shows an obscurely segmented axis, and pleural furrows of apparently six segments (the specimen suggests that an exfoliated pygidium might show segments more clearly), three pairs of lateral furrows, with one pair of interpleural furrows on the first lateral segment. The pattern is faintly reminiscent of the condition found in *Bolbocephalus,* which, however, has more interpleural furrows.

Figured specimen.—No. 2158, José formation, Cooks Range, New Mexico.

BRIDGEINA Flower, n. gen
Genotype: *Bridgeina carinifera* Flower

This name is proposed for some small gastropods of the José formation, which resemble *Bridgeites* in the faintly depressed spire and the faintly concave undersurface, but in which the ridge marking the selenizone or silt is close to but not at the outer angle, and is seen in early whorls close to but distinct from the outer suture of the ramp. The outer wall is more or less flattened, but slopes inward slightly from top to bottom. The rounded under surface approaches the parietal wall curving variously, but the parietal wall is scarcely excavated, but is flattened, the plane sloping obliquely in from top to bottom, to conform with the outer wall of the preceding whorl.

While close relationships in these early Paleozoic gastropods are a hazardous subject for conjecture, it might be suggested that in the Lower Canadian there is *"Helicotoma" uniangulata,* a species for which in the accompanying paper on the Fort Ann limestone fauna, the genus *Prohelicotoma* is proposed. This has a very low spire, and is a form in which the ridge marking the slit lies on the outer side of the ramp, but is not at the angle of the suture. In *Bridgeina* the whorl is similar in section and in the position of the ridge, but here the top is slightly hyperstrophic, and the bottom faintly concave. A next logical step is *Barnesella,* in which the spire is slightly more concave, and the base is flattened. This hypothesis unfortunately leaves out of the reckoning the Middle Canadian genus *Lecanospira,* which, like *Barnesella,* has a concave spire and a flat base, and also has the ridge on the ramp, though more elevated than in true *Barnesella.* The writer would not, however, agree with the American Treatise, that *Barnesella* is necessarily a subgenus of *Lecanospira;* the upper side of the shell is not as markedly elevated into a ridge marking the slit as in the illustration in the treatise volume (p. 1188, fig. 105, 1).

The two species here described, I at first attempted to place in *Barnesella,* which seems unsuitable from its flat base, and in *Bridgeites,* which is unsuitable as the outer wall does not slope inward from top to bottom, and the ridge lies at the outer angle of the whorl rather than just free from it on the ramp.

Lesuerilla as here interpreted, is a shell which, like *Barnesella* has both the spire and the base concave, but the whorls are more rounded, the ridge marking the slit is commonly inconspicuous, and the outer wall is rounded instead of flattened.

Bridgeina carinifera Flower, n. sp.
Pl. 4, fig. 10, 11, 13, 15.

This is a small discoidal shell, faintly concave on both surfaces. Our largest specimen is 16 mm across, and contains four whorls, though the species may have a half-whorl more. Anterior parts of this form showed a tendency to crumble in extraction. The upper surface is faintly concave. The ramps exposed slope up faintly from the inner to the outer suture, and close to the ramp is a ridge, marking slit or selenizone, outside of which the whorl begins to become convex. The outer angle is broadly rounded and gives way to an outer wall, slightly convex, but definitely flattened, the flattening forming a plane which slopes faintly inward from the top to the bottom, merging into the under surface, which is slightly convex. As the umbilicus is approached, the convexity of the whorl margin increases, giving way to a strongly convex umbilical wall, which is slightly shorter than the parietal wall above; this is slightly excavate, but is largely a flat surface sloping obliquely in from top to bottom, to conform with the outer wall of the preceding whorl.

Our several specimens show little variation. The holotype (Pl. 4, fig. 10, 11), is selected as a piece missing from the outer whorl shows the whorl sections clearly; it is 16 mm across. A larger paratype measures 18 mm (Pl. 4, fig. 15), but shows whorl sections less completely. The several whorls which show cross sections clearly show the width and height of the whorls to be equal.

Discussion.—*B. rotunda* has the upper surface of the whorl less flattened, the ridge is less prominent, generally obscure or wanting in the young, the outer wall is more rounded, particularly in later whorls, and the lower wall curves more uniformly, so that there is no prominent more strongly rounded umbilical wall region below the parietal wall.

Types and occurrence.—Holotype, no. 1256, figured paratypes nos. 1252 and 1254; all from the José formation of the Cooks Range. The species is common and has been observed in nearly every section in which the horizon has been collected.

Bridgeina rotunda Flower, n. sp.
Pl. 4, fig. 7-9, 12, 14

This is a small shell like the preceding in general proportions, though ranging slightly smaller, our largest specimen measuring 14 mm across, and showing four whorls. The upper surface of the whorl, the ramp, is slightly less flattened, and less inclined upward from the inner to the outer angles than in the preceding, and the ridge marking the slit is poorly defined in the young stages, and not apparent on all of our specimens. A faint ridge is evident on Pl. 4, fig. 12, but not on Pl. 4, fig. 7. The outer whorl is flattened, the plane of flattening inclined faintly inward from top to bottom, as in the preceding species, but the flattening is less marked, and the obliquity is less marked in outer than in inner whorls. The outer wall rounds to continue as the lower wall, which is gently rounded, sloping gently upward to join the preceding whorl, without showing the strong convexity of the umbilical wall of *B. carinifera.* Distinction of the species is discussed under that species. In this form the outer whorls at least, show consistently a height slightly greater than the width; in the holotype the width is 2.1, the height 2.3 mm; in one paratype the width is 3.0 mm, the height 3.4 mm.

Types and occurrence.—Holotype, no. 1254, paratypes nos. 1251, 1253, 1255, 1257. The types are from the José formation of the Cooks Range; the species has been observed in the Mud Springs Mountain, the Hatchet Mountains, Lone Mountain and in sections of the Black Range and San Andres Mountains.

Hormotoma zelleri Flower n. sp.
Pl. 4, fig. 16

This is a small *Hormotoma* of rather gently rounded whorl profile, rather common in the José formation. The type retains three and a half whorls, is 21 mm long, 8 mm wide, and has an apical angle of 15°. The whorl outline is convex externally, without flattening, attaining the greatest breadth one-third the distance from the base to the top; the lower margin is quite well rounded. The whorl surface is smooth, and though we have had a number of specimens, no trace of growth lines nor of a slit or ridges can be seen. The shell was apparently thin and certainly quite smooth.

Discussion.—Though this is quite common in the José formation, without similar forms in the formations above or below, our specimens are irritatingly poor, being given to crumbling in extraction. Though it is a species of rather generalized aspect, there are no comparable forms described which resemble it really closely.

Type and occurrence.—Holotype, no. 1299; from the José formation of the El Paso Group, Cooks Range, New Mexico. The species has been observed in collections from the Hatchet Mountains, the Mimbres Valley, Mud Springs Mountain and the Florida Mountains. Fragmentary silicified specimens apparently of this species, have been obtained in the southern Franklin Mountains at El Paso.

VII MUD SPRINGS FORMATION

Genus *BRIDGEITES* Flower, n. gen.

Genotype: *Bridgeites discoideus* Flower, n. sp.

This is a discoidal gastropod of four or more gently enlarging volutions. The spire appears flat but is actually very faintly concave. Whorls are closely appressed, the tops nearly flat, with fine incised sutures, between which each whorl shows an upper surface faintly convex in the center, concave on either side, and raised again close to the suture. The outer keel is sharp; beneath it the wall is vertical for most of the height of the whorl, then curves to the strongly convex undersurface; the parietal wall is concave below and nearly

straight and vertical above to accommodate the preceding whorl.

Discussion.—None of our material shows growth lines or a complete aperture, but a shallow slit is believed to be present on the outer angle. *Ophileta* and the allied *Ozarkispira* are somewhat similar in the smoothing of the upper surfaces of the whorls; this genus might be considered a modification of them, differing in that the low cone is so flattened as to be most faintly concave. *Ozarkina* is a similarly nearly planispiral shell, but it is known from much smaller species of the Lower Canadian, and the upper surfaces of the whorls are gently convex, separated by more prominent sutures, and are not smoothed. Our form differs from simple Macluritidae in that the undersurface is concave and not flattened as in *Lecanospira.* Euomphalidae have the outer side of the whorl convex and curved, instead of straight and vertical.

The one known species is confined to the Mud Springs formation of the El Paso group, the *Bridgeites* reefs. It is this form to which reference was made in some earlier summaries of the El Paso as characterizing the "*Orospira*" reefs.

Bridegeites discoideus Flower, n. sp.

Pl. 3, fig. 26-33

This species has the characteristics of the genus. Our most complete specimen (Pl. 3, fig. 27, 28) shows a clean undersurface with four visible whorls, though possibly two are obscured in the umbilical region. The top shows the characteristics of the whorls described, but could not be perfectly cleaned because of fragility; it is evident that the top and outer wall of the last whorl are broken. The shell is 32 mm across and shows a penultimate whorl 4 mm high and 4 mm wide on both the spire and the umbilical surface. A second specimen (Pl. 3, fig. 26) shows six whorls and part of a seventh, but only the upper side is preserved. The maximum diameter is estimated as 36 mm. A third specimen (Pl. 3, fig. 32, 33) shows a broken umbilical surface; a cross section was made of another specimen (Pl. 3, fig. 31) showing the section of the whorls, but wall preservation is incomplete.

Discussion.—This species is readily recognizable, and there is nothing else in the El Paso group that can be confused with it readily on the basis of general aspect and proportions. It is confined to the Mud Springs formation. It is far from uncommon, but specimens are difficult to extract and we have no really good shell surfaces. The types are from the Mud Springs Mountain. The species has been recognized also in other sections, notably the Cooks Range, the Florida Mountains, the Big Hatchet Mountains. The species is wanting, as are the beds containing it, in the Franklin Mountains, though developed in the San Andres farther north, where, however, this species is uncommon.

Types.—The six specimens on which the description is based, regarded as syntypes, are nos. 1200-1205 in the collection of the writer. They are from the Mud Springs Mountain section.

VIII SNAKE HILLS FORMATION

Lloydia (Leiostegium) sp.

Pl. 4, fig. 1, 2, 5.

The cranidium shows a narrow raised border, behind which are two deep pits, one on either side of the anterior end of the glabella. The glabella is more transverse in front than in the preceding form, sides diverge posteriorly, slightly more convex in outline than in *L. manitouensis,* the occipital furrow is shallower, the occipital ring broader and more elevated. The crandium is 13.5 mm long and 17 mm wide.

A second incomplete crandium, (Pl. 4, fig. 5), 17 mm long and 20 mm wide, is incomplete posteriorly, but shows the narrow brim crossing in front of the glabella; proportions are similar, though the illustration shows the head tilted back so that the anterior brim is more readily seen.

A pygidium, shown in Pl. 4, fig. 2, shows proportions much like those of *L.* cf. *manitouense,* but the brim is different; its furrow is deep, beyond which the brim becomes a sharp raised ridge, beyond which it slopes sharply down to the periphery. The specimen is 21 mm wide and 16 mm long.

Figured specimens:—Nos. 1300-1303, from a calcarenite lens in the Snake Hills formation, Pierce Canyon, on the east side of the Black Range, New Mexico.

IX SCENIC DRIVE FORMATION

PARARAPHISTOMA VOSTAKOVA 1955

Genotype: *Helicites qualteriatus* Schlotheim

Some difficulty has surrounded the question of the proper scope of this genus, which I will not attempt to solve, preferring to leave the matter to those more widely experienced in the Gastropoda. The present concept of the genus rests in part upon a translation of the generic description, supplied by Dr. Ellis Yochelson, and in part from the study of specimens of the genotype loaned to me, through Dr. Yochelson's efforts, from the U.S. National Museum.

The shell forms a low broad conical spire, with the ramp flattened, and sutures moderately obscure externally. The reputed scalariform profile of the tops of the whorls is a feature apparent on internal molds, but results from exfoliation of a shell which is thickened on the proximal end of the ramp, where it approaches the suture. The spire is more conical and less lenticular in profile than in *Proliospira,* and the height of the whorl in cross section is greater in proportion to its width; also, a considerably greater proportion of the whorl-height lies below the outer angle. Growth lines on the ramp swing backward from the suture to the outer angle, curving slightly; the outer angle bears a short notch or slit; as is so common in Paleozoic material, the exact extent of this emargination is not clearly shown; below the outer angle the growth lines curve gently forward to the umbilical region. *P. lemonei* shows there a rugosity not apparent in *P. qualteriata.* In other respects the two species are quite similar in general aspect and gross proportions. *P. qualteriata* is from the Vaginatinkalk of the Baltic region, a horizon which is believed to be of Whiterock age in terms of the American Ordovician; *P. lemonei* is from beds of Cassinian, Late Canadian age.

Pararaphistoma has been compared with *Raphistoma* and *Raphistomina.* It should be pointed out that in cross section of the whorl it is also quite close to the dominantly older genus *Ophileta*; both genera show the upper ramp flattened, conforming to the low broad conical spire, a sharp outer angle, with much of the total height of the whorl below this angle, where the wall first slopes obliquely down and back, and then curves to the umbilical suture. Typical

Ophileta is developed in the Lower Canadian; there shells are dominantly though not universally small, whorls enlarge gently, and most specimens, which we may hope represent reasonably mature shells, show more whorls than does *Pararaphistoma.* There are, however, Middle Canadian species assigned to *Ophileta* which range larger in size and show whorls enlarging more rapidly, with fewer whorls in typical shells; such shells approach *Pararaphistoma* more closely. Some confusion surrounds the genus *Roubidouxia,* first published by Butts (1926, pl. 17 and its explanation), and regarded for some time as a genus characteristic of the Middle Canadian. Cloud and Barnes (1948, p. 62, 115), regard *Rhombella* as largely replacing *Roubidouxia* for Middle Canadian species. The American Treatise treats *Roubidouxia* as a synonym of *Schizopea* Butts 1926, but places *Rhombella* in the dominantly younger family Luciellidae. It differs from *Pararaphistoma* and *Ophileta* in that the smooth conical spire is higher, though ramps are similarly flattened, conforming to the nearly smooth conical upper surface. The outer angle is sharp, and lies so low on the whorl that there is no appreciable whorl height below it, though it would seem that a marginal frill, considered a criterion of the family Luciellidae, is not adequately demonstrated for this genus.

P. lemonei consists of a suite of silicified shells etched from limestone. All specimens lack good apices, a phenomenon which at first seemed a quirk or preservation. Calcitic material of *P. qualteriata* shows, however, that apices of that species develop diaphragms, and that calcite commonly fills the spaces between the diaphragms. It is common in silicious replacement of calcitic material, that silicification is imperfect or wanting where calcareous material is extremely thick as, for example, in the thick ventral beaks of brachiopods. Failure of silica to replace calcite-filled apices of *P. lemonei* supplies an explanation of the consistent failure of the apices of that species to be silicified and suggests that the development of diaphragms, not ordinarily valued as a criterion in gastropod taxonomy, is common to these two species; it may well be characteristic of *Pararaphistoma* as a genus, and is a convincing explanation also for exfoliation of apices with the shell wall, in calcitic specimens of the related genus *Proliospira.*

Sando (1957, pl. 12, fig. 3) has figured as *Ophileta* sp. a shell from the *Lecanospira* beds of the Rochdale Run limestone of Maryland, a specimen which again emphasizes the similarity of the larger species of *Ophileta* of the Middle Canadian with *Pararaphistoma. Eotomaria depressa* Cullison (1944, pl. 30, fig. 7-9), appears to be a species of *Pararaphistoma,* rather than of the dominantly younger genus *Eotomaria.*

Pararaphistoma lemonei Flower, n. sp.

Pl. 5, fig. 17-30

This is a moderately large low conical shell, remarkably similar in size and proportions to *P. qualteriata.* The upper surface shows commonly two and a half to three whorls, with the early whorls, commonly destroyed, to an extent that varies with the size of the shell; the absence of such early portions is regarded as failure of the early parts to silicify, because they were traversed by diaphragms, with the result that spaces between the diaphragms became filled with inorganic calcite early in the history of preservation. The ramps are nearly flat, the surface convex near the suture, faintly concave on the outer half. Sutures are apparent externally, but are never deeply incised. Growth lines curve back from the suture toward the outer angle, which is sharp, but without clear markings; presumably a short notch or slit. Below the outer angle, the wall slopes inward, showing slight flattening on an oblique surface below the angle, but then curves gently inward and upward to form a rounded lower lip, the wall of which slopes inward and upward to the umbilical suture; here growth lines slope at first forward from the outer angle, but become transverse and faintly rugose over the greater part of the exposed lower lip, as viewed from below. The parietal wall is slightly sinuate, convex above, then becoming faintly concave to receive the lower rounded portion of the preceding whorl, and bending at an angle of about 45° where it turns to form the lower lip. Where the aperture is 15 mm high and 21 mm wide, the slope of the upper ramp occupies less than one-third the total whorl-height, and the upper ramp accounts for only two thirds of the total width. Selected representatives of our several specimens show the following dimensions:

Shell height	Shell width	Whorl height	Whorl width	Length of ramps, from last to earlier whorls
18	40	14	19	11, 7, 5, — —
21	47	15	22	11, 7, 5, — —
22	53	17	22	12, 8, — — —
24	53	17	22	12.5, 9, 5.5, — —

Some variation in proportion is indicated, but the specimens show a general uniformity

Discussion.—This form is very similar in size and general aspect to *Pararaphistoma qualteriata* Schlotheim. That species shows, where shells rather than internal molds are preserved, a somewhat smoother ramp, but where the shell is exfoliated, thickening of the shell on the ramp close to the suture produces a scalariform appearance of internal molds which is false as far as shell exteriors are concerned. *P. qualteriata* ranges somewhat larger in size, and from the specimens I have seen, shows a whorl which is not quite as high as in *P. lemonei* from the outer angle to the lower curve of the under lip, and does not show rugosity of the growth lines on the under lip.

I have collected a specimen of somewhat similar aspect but consistently smaller size in the Wahwah limestone of western Utah; this horizon, zone J (Hintze 1951, 1952), is slightly younger than the El Paso occurrence; the equivalent of zone J in the El Paso group is to be found in the Florida formation, an interval which, whether from the nature of preservation or from the type of environment, has not yielded as yet any similar gastropods.

Types and occurrence.—Holotype, no. 1216, paratypes, nos. 1217-1222, collection of the writer. All are from a single 3′ layer of black limestone containing fossils and nodules preserved in russet-weathering chert, roughly in the middle of the 226′ of limestones comprising the upper member of the Scenic Drive formation, B2b of Cloud and Barnes, exposed at Nameless Canyon, just west of Ranger peak, in the Franklin Mountains north of El Paso, Texas. The black bed

lies just above a conspicuous buff-weathering bed which is a source of conspicuous silicified cores of sponges; both are convenient zone markers in the limestones of the Scenic Drive formation, the black bed has been found at the Scenic Drive section 68′ above the base of the limestone, below which are 60′ of dolomite. The layer at the Scenic Drive has yielded no silicified fossils; silicification may not have occurred there, but observations are limited, as the bed dips into the hillside, and there are no such conspicuous areas of its surface exposed there as there are at Nameless Canyon, where the bed is exposed abundantly on a dip slope.

MACLURITES Lesueur

Genotype: *Maclurea magna* Lesueur

Much perplexity has surrounded this genus, because shells of this aspect are wide-ranging. The genotype is a common fossil of the Chazy limestone. Ulrich and Schofield (1897) separated younger forms as *Maclurina*; unfortunately shells are so much alike as to be indistinguishable except on the basis of the operculum; that of *Maclurina* has a tooth on its inner surface. Not only do shells of this aspect range from the Chazy to the Red River and possibly higher, but others appear earlier, in the higher Canadian. Current investigations by Dr. Yochelson which I do not wish to anticipate, indicate that Canadian forms are again distinctive on the basis of the operculum. In the meantime records of shells of this aspect in the Canadian have remained largely unrecorded in the literature. In the El Paso, I have described below one form from the black bed of the Scenic Drive formation; there is additional material both from elsewhere in this formation, and from the overlying Florida formation. None have as yet been found in direct association with operculae, though operculae of the general aspect of *Maclurites odenvillensis* Butts (1926) are known from these formations. I have regarded shells of this type as particularly characteristic of the Cassinian, and more particularly though not exclusively, of the latest Cassinian. Hall described from near Glens Falls, New York, a small poorly preserved species as *Maclurea sordida*. This form I have found filling a few beds of limestone in the Fort Ann region, occurring in the highest beds of the Providence Island dolomite, and exposed along the Mettawee River.

Maclurites nanus Flower, n. sp.

Plate 2, fig. 1-9

This is a small *Maclurites;* known specimens show indication of three whorls, and attain a diameter estimated as 22 mm as a maximum. The flat base is separated by a strongly rounded angle from an outer surface which is faintly convex, sloping in toward the axis of the coil as it is traced upward; the surface is moderately flattened, well inclined in early whorls, steepening, as growth progresses, and making an angle of 45° with the base adorally. The top bends abruptly to form an inner lip which is curved, becoming vertical where it joins the preceding whorl, bending again to form the parietal lip, which is nearly straight, sloping outward below, and covering a good part of the dorsal surface of the preceding whorl. The umbilicus as seen from above is deep, but open; that our specimens show only one and a half whorls from above is due to poor preservation of initial portions of the shell.

The holotype, Pl. 3, fig. 1-3, shows a rather well preserved basal surface, with three whorls evident. Restoration of the last quarter volution gives a shell 22 mm across. The last point at which the whorl can be measured shows a height of 6 mm, and a width of 7 mm. In the last whorl the height increases slightly more rapidly than does the width.

A paratype, Pl. 3, fig. 4-6, shows the last quarter of the whorl again incompletely preserved, but illustrates the cross section of the whorl more clearly; here where the shell is 18 mm across, the last whorl is 8.5 mm high, 8 mm wide with the preceding whorl which it embraces, 5 mm high. A second less complete paratype is figured in Pl. 3, fig. 7-9. A third paratype is unfigured.

Discussion.—The proportions characterize this species, in particular the rapid increase in whorl height, the adoral steepening of the outer ramp, the vertical position of the inner lip just above the suture.

Types and Occurrence.—From the black bed in the middle of the limestones of the Scenic Drive formation, Nameless Canyon, southern Franklin Mountains. The holotype is no. 1223, the paratypes nos. 1224-1226.

Hormotoma moderata Flower, n. sp.

Pl. 2, fig. 10

Shell high-spired, moderately enlarging. Apically, the shell shows a spire of about 22°, which is maintained up to a shell diameter of 12 mm, beyond which the rate of enlargement is reduced to an angle of 16-18°. Whorls are evenly rounded externally apically, but adorally the greatest width lies below the center of the exposed ramp. A slit is indicated slightly below midheight of the whorl. Whorls are slightly irregular in enlargement, but successive whorls on the holotype show heights of 3, 5, 7 and 11 mm, while on the paratype, which is larger but has early whorls lacking, heights are 6, 9, 11 and 15 mm. Complete shells have not been observed, but probably consisted of between five and six whorls. The holotype is 30 mm long and 12 mm across; the paratype is 43 mm long, enlarging from 3 to 15 mm.

Discussion.—This belongs to a group of species with the cone moderately wide-angled, whorls fairly rapidly increasing in length. *H. obeliska* of the Ft. Cassin beds has whorls more evenly rounded, not markedly widened below adorally; *H. dubia* also shows whorls more convex in outline; *H. cotterensis* is somewhat similar, but shows whorls more flattened and more rapidly lengthening.

Types.—Holotype and paratype, no. 1227 and 1228, from a black limestone in the middle of the limestones of the Scenic Drive formation, from Nameless Canyon, of the southern Franklin Mountains, due west of Ranger Peak.

Plethospira (?) *rotunda*

Pl. 2, fig. 14-16

This is an odd shell with an apparent siphonal canal low on the whorl, whorls rapidly expanded, well rounded above, the under lip curving down becoming concave around a

rather narrow umbilical region which is produced downward into a possible siphonal canal, smaller, more extended and more prominent than is usual in *Plethospira*. The spire shows an angle of 75-80°. Ramps are well rounded, with a slight angulation just below the middle, that may well represent the position of a notch or slit, though this is uncertain as growth lines are not preserved. Successive ramps increase from 2 to 6 and to 11.5 mm, where the shell has diameters of 4, 9 and 18 mm respectively.

The rounding of the lower lip, the apparent extensive development of the columella below, are somewhat more suggestive of the materially younger genus *Diplozone*, than of contemporaneous species of *Plethospira*.

Discussion.—The rapid expansion, the even rounding of the ramp instead of development of a slightly flattened oblique sloping upper surface, the rounding of the whorl below, and the extension of the narrow columella region, distinguish this species.

Type and occurrence.—Holotype, no. 1229, from the black limestone in the middle of the limestones of the Scenic Drive formation, from Nameless Canyon, southern Franklin Mountains, west slope, west of Ranger Peak.

Sinuopea sp.
Pl. 5, fig. 11-13

Under this designation I figure a rather odd broad-spired shell of four whorls. The cone has an angle of 55-60°, whorls are rounded above fairly rapidly enlarging, the ramps increase 4, 6 and 12 mm with shell widths as 7, 10, and 17 mm. The outer surface of the whorl is rounded, rounding continuing evenly below, to a small umbilical perforation.

Discussion.—This is clearly a shell of the general aspect of *Sinuopea*, other species of which occur in Gasconadian and Demingian faunas. Our one known specimen from the Cassinian is a rather imperfect shell with growth lines scarcely indicated. The parietal lip is not clearly shown, but evidently modification of the section to receive an earlier whorl is only a minor concavity. Whorl section suggests a normal coil, rather than such orthostrophic genera as the macluritids.

Figured specimen.—No. 1230, from the black limestone in the middle of the limestones of the Scenic Drive formation, from Nameless Canyon, just west of Ranger Peak, southern Franklin Mountains.

PART II

FOSSILS FROM THE SMITH BASIN LIMESTONE OF THE FORT ANN REGION NEW YORK

Abstract

Eleven species of fossils of the Smith Basin limestone of the Fort Ann region in New York are described and illustrated. The fauna is of late Gasconade age and affinities.

Introduction

The Smith Basin limestone (*see* Flower, 1964, p. 153 ff.) has yielded a prolific assemblage of Ellesmeroceratida, which the writer has described previously (Flower 1964). With it are some other significant fossils, the more prominent of which are here described and illustrated. I had hoped that in the meantime these would be treated by specialists in the various systematic groups, as some problems exist at the generic level which I cannot hope to solve properly. It nevertheless seems desirable that more of this fauna, which first came to my attention in 1940 or 1941, be described and illustrated.

The forms herein described are as follows:

Taeniospira? naticoides
Rhacopea angulata
Prohelicotoma uniangulata (Hall)
Sinuopea sp.
Yochelsonella compressa
Palaeacmea expansa
Arcinacella magna
A. parva
Paraplethopeltis carinifera
Remopleuridella (?) obtusa
Leiocoryphe (?) lobata

The fauna contains some other forms not described here. There is a small *Finkelnburgia,* rather rare and generally poorly preserved, and chance cuts made for other material have yielded small *Lichenaria* colonies. The limestone also contains calcareous algae, which form hemispherical masses of 2-3″ in diameter.

The cephalopods previously described (Flower 1964) include:

Ellesmeroceras indomitum
E. inbricatum
E. fusiforme
E. progressum
Eremoceras multicameratum
E. perseptatum
E. magnum
E. sp. cf. *magnum*
E.(?) *expansum*
Ectenolites penecilin
E. curviseptatus
E. sinuatus
E. simplex
Annoceras costatum
A. perobliquum
A. elevatum
Paradakeoceras planiventrum
Clarkeoceras ruedemanni
C. trapezoidale
C. rhomboidale
C. (?) sp.
Conocerina reducta
Keriaceras (?) percostatum
Buehleroceras sinuatum
B. arcuatum
B. infundibulum

The fauna is of Gasconade age, and contains some forms, as one might expect, similar to those found in Gasconade beds in Missouri (see Bridge, 1930), and also to some forms described from the Wanwanian of Manchuria by Kobayashi (1931, 1933). Similarities are more significant than apparent differences; neither fauna is really completely known. Striking similarities with the Wanwanian are found in the presence here of Monoplacophora, but there are also such forms in the Gasconade, a few of which have been described subsequently (Yochelson, 1958).

Some identical or comparable forms from faunas of Gasconade age and aspect have been figured by Butts (1926, 1940) and Cloud and Barnes (1948). Traces of an allied fauna occur in the Halcyon Lake dolomite of the southern Hudson Valley, (Knopf, 1962) but dolomitization there has destroyed most of the fossils. The Tribes Hill limestone of the Mohawk Valley, the nearest occurrence geographically to ours of beds of the same age, contains a very different fauna (Cleland, 1900, 1903, Fisher, 1954). The writer is in agreement with the late Dr. Josiah Bridge in attributing the differences to environmental rather than temporal causes. The Smith Basin limestone is a fine-grained light-gray limestone, comprising the top of the Great Meadows formation, and has yielded a considerable abundance of fossils under persistent collecting. It should be noted that the underlying dolomites of the Vly Summit member have yielded some similar fossils, but they are confined to chert nodules, and are scarce and most poorly preserved. The underlying Skene member is a dominantly non-cherty dolomite, largely barren, but locally a few lenses have been found which remain limestones; some of these have yielded faunas. One, a 3 foot ledge low, in the type section east of Smith Basis, has yielded no *Paraplethopeltis* or *Prohelicotoma,* but has instead a hystricurid, not found in the upper members.

Descriptions

GASTROPODA

Taeniospira? naticoides n. sp.

Pl. 6, fig. 17, 18

This is a small almost globose shell, rapidly enlarging, the whorls evenly rounded, the last whorl embracing nearly three-fourths of the preceding one. The type is 14 mm high, 22 mm across, with the width of the last half whorl outside the suture increasing from 4 to 8 mm in the last whorl. Where the last whorl is 12 mm high, the spire, of probably two volutions, is 4 mm.

Discussion.—This little globose shell is distinctive, but our material leaves it open to be interpreted as either of two distantly related genera, *Scaevogyra,* which is hyperstrophic, and *Taeniospira,* which has a normal spire. I have chosen *Taeniospira,* inasmuch as *Scaevogyra* shows an angulation in the upper part of the whorl, while our form seems well rounded on what is interpreted the bottom. The form bears a strong resemblance to Kobayashi's (1933) *Scaevogyra ulrichi,* but the hyperstrophic nature of that form seems dubious. *Taeniospira eminencenis* has a slightly higher spire and is a larger less rapidly enlarging shell. Both *Taeniospira* and *Scaevogyra* are based on Cambrian species of the Ozark uplift.

Type and occurrence.—Holotype, no. 1177, collection of the writer, from the Smith Basin limestone, ¼ mile east of Smith Basin, New York.

Rhachopea angulata Flower, n. sp.

Pl. 6, fig. 24, 25

This form differs from *R. typica* in several respects important enough that it may eventually be set apart in a new genus. Discoidal, phaneromphalous gastropod, encompassing at the most two observed whorls, and attaining a diameter of 28 mm, spire flat, whorls loosely appressed. Mature whorl with upper surface slightly flattened near the suture, then curving to a nearly flat oblique surface terminating in a prominent marginal keel on either side of which the section may become narrowly concave. The under and upper surfaces meet at an angle normal to the plane of symmetry on the keel. Below, the under surface becomes increasingly convex and finally strongly rounded as it approaches the umbilicus, which is widely open. The outer whorl obscures about the outer half of the width of the preceding whorl on the venter. Growth lines slope strongly backward from the umbilicus and suture to the marginal angle marking the selenizone. In later stages this is strongly keeled, and strongly emarginate above but not below.

Type and occurrence.—Holotype, collection of the writer, no. 1179, Smith Basin limestone, in the section ¼ mi. east of Smith Basin, New York.

PROHELICOTOMA Flower, n. gen.

Genotype: *Helicotoma uniangulata* (Hall)

This genus is erected for the widespread Gasconade species previously known as *Helicotoma uniangulata* (Hall). The shell has a spire which is flat to very slightly concave, instead of convex as in true *Helicotoma.* The under side shows a wide umbilical opening, so that at least half of the width of the preceding whorl is visible from that view; in *Helicotoma* about one fourth of the early whorl can be seen, and indeed, the umbilical perforation of a mature specimen is about one fourth the diameter of the shell. The upper surface shows a prominent ridge representing the slit, which lies on the ramp near instead of upon the outer angle, so that the ridge is always apparent in early whorls, instead of being obscured by or coinciding with the outer suture. Further differences are found in the cross section. In *Prohelicotoma* the whorl is a transverse oval or ellipse in section, and is scarcely emarginate to receive the earlier whorl. The selenizone, though prominent externally, makes hardly any modification in the cross section of the whorl, and above it the shell surface is convex and not slightly concave. Below it the oval of the cross section is continued unmodified, whereas in *Helicotoma* the shell wall becomes abruptly nearly vertical at this point.

It should be noted that in addition to *P. uniangulata* which is apparently quite wide-ranging in North America, from eastern New York to Central Texas, the Wanwanian *Helicotoma wanwanensis* Kobayaski (1931) is probably congeneric.

Prohelicotoma uniangulata (Hall)

Pl. 6, fig. 27-29

Euomphalus uniangulatus, Hall, 1847, Paleontology of New York, vol. 1, p. 9, pl. 13, fig. 1, 1a.

Straparollus uniangulatus Emmons, 1855. Amer. Geology, vol. 1, pt. 2, p. 157.

Helicotoma uniangulata Salter, 1859. Geol. Surv. Canada, Decade 1, p. 13.

———— Butts, 1926. Alabama Geol. Surv., second ser., vol. Sp. Rep. 14, p. 90, pl. 15, fig. 1-7.

———— Bridge, 1930, Missouri Geol. Surv., second ser., vol. 24, p. 116.

———— Butts, 1940, Virginia Geol. Surv., Bull. 52, pt. 2, p. pl. 68, fig. 8-9.

———— Cloud and Barnes, 1948, Univ. of Texas Publ., no. 4621, pl. 40, figs. 16-20.

Not ———— Fisher and Hanson, 1951, Amer. Jour. Sci., vol. 249, p. 807, pl. 1, fig. 9.

Shell with a spire which is flat or slightly concave, attaining one and a half to two whorls, attaining a width across the whorl of 32 mm. Whorls narrowly in contact, with a vestigial emargination for the reception of the inner whorls. Whorl section transverse elliptical, lower wall and umbilicus evenly rounded; upper outer margin slightly modified by a narrow faintly raised line marking the position of the slit. Above this the margin section is faintly concave. The upper margin becomes steepened, nearly vertical, as it approaches the region of the inner suture. Below this, there

is a very faint concavity for the reception of the previous whorl. The umbilicus is widely open; the outer whorl conceals about one fourth of the width of the preceding whorl. On the dorsum the raised selenizone line is the conspicuous feature; growth lines are obscure. On the lower side low broad transverse markings indicate the growth lines. They slope faintly backward as they approach the region of the selenizone.

This species, widely known as *Helicotoma uniangulata,* is a widespread and characteristic species in the Gasconade and its equivalents throughout eastern North America. Indeed, the name is so widely known that I tamper with it only with some reluctance. However, as pointed out in the generic description, this widespread Gasconade form differs from typical *Helicotoma* in several important respects; further, true *Helicotoma* is a much younger form, being concentrated in the Middle Ordovician. Therefore the new generic name *Prohelicotoma* is proposed. The species name is also a matter of perplexity. I am inclined to believe with Bridge (in conversation and correspondence) that the Gasconade is characterized mainly by one widespread species showing some variation in size and proportions, rather than a series of species of the same age throughout North America. The use of Hall's species for this form has some unsatisfactory aspects. *Euomphalus uniangulatus* Hall was based upon a specimen "found loose in a mass of the Calciferous rock, in Saratoga county." Thus the stratigraphic and true geographic origin of the species is unknown. I have been unable to locate the type specimen, and for a time considered the advisability of abandoning Hall's specific name for that reason. However, two fairly good plaster casts of this specimen exist, one in the New York State Museum, the other at the U.S. National Museum. The species has not been found again in Saratoga County or, indeed, in the Mohawk Valley. Fisher and Hanson (1951) have identified as this species a really unidentifiable specimen from the Gailor dolomite. Their form may or may not be *P. uniangulata,* but a specific identification is certainly somewhat optimistic on the basis of the specimen which they illustrate and which I have seen.

The above description and the accompanying illustration are based upon a specimen from the Smith Basin limestone of the Smith Basin section, Fort Ann quadrangle, New York. It is, to my knowledge, the first occurrence of this species in New York found *in situ.* Poorly preserved specimens, sometimes preserved in chert, are occasionally found in the upper cherty half of the Great Meadows formation. None have been found in the lower half. Bridge (1931) notes that this species is a useful zone marker in the upper part of the Gasconade dolomite of Missouri. Butts (1926, 1940) has found it abundant in the equivalent Chepultapee dolomite of the Appalachian Valley from Virginia to Alabama. Cloud and Barnes (1948, pl. 40, fig. 15-20) figures typical examples from the Tanyard, the Gasconade equivalent, of central Texas. I have not found the species in the Gasconade equivalent in the El Paso limestone of west Texas or New Mexico, and to my knowledge, the species has not been found in the equivalent beds anywhere in the Cordillerian region.

Figured specimen.—Collection of the writer, No. 1178.

Occurrence.—From the Smith Basin limestone, in the section east of Smith Basin, Fort Ann quadrangle, New York.

Sinuopea sp.
Pl. 6, fig. 33.

The Smith Basin limestone has yielded fragments of a large *Sinuopea,* none adequate for close specific analysis. The specimen here figured, the most complete one yet found, shows a weathered section of a shell 70 mm long 50 mm wide, giving some idea of the impressive size of this form, the largest gastropod of the member. In the last whorl, the section appears to be nearly tangent to the shell. The section is apparently oblique, not showing the full height of the spire, and probably does not attain the full width of the shell. Large *Sinuopea* are typical of Gasconade faunas. *S. regalis* Ulrich was first published in Butts, (1926), pl. 21, fig. 3, based on a specimen from the Chepultapec of Alabama. Bridge (1931) figured a specimen from the Gasconade of Missouri.

Figured specimen.—Collection of the writer No. 1181, from the Smith Basin limestone, from the section just east of Smith Basin, N.Y.

MONOPLACOPHORA

YOCHELSONELLA Flower, n. gen.

Genotype: *Yochelsonella compressa* Flower, n. sp.

This is a conical shell, so nearly alike in anterior and posterior profiles that it is uncertain which is which. Sides are strongly flattened in cross section, dorsum and venter strongly rounded. Unlike *Hypseloconus,* there is no clear concave profile on the anterior side.

Yochelsonella compressa Flower, n. sp.
Pl. 6, fig. 26.

This is a monoplacophoran which is nearly conical, moderately expanding in profile, with an angle of 70°-75° basally, reduced adorally to about 55°. The lateral sides diverge much more slowly, 25-35°, resulting in a strongly compressed shell. The internal mold shows faint longitudinal striations, and a suggestion of a ring-shaped muscle scar. This is a distinctive element in the Smith Basin faunas, though not common.

Type and occurrence.—No. 1181, from the Smith Basin limestone, from the section just east of Fort Ann, New York.

Palaeacmea expansa Flower, n. sp.
Pl. 6, fig. 22, 23, 32

This is an essentially erect conical shell, the expansion of which increases adorally. The type has the apex missing, is 24 mm long, 15 mm wide and 11 mm high. It shows on its surface fine growth lines, but no trace of muscle scars. If our orientation is correct, the lower side in Pl. 6, fig. 23 is anterior, it being the more narrowly rounded of the two ends; if so, in profile the apex is pointed very slightly forward, the left of Pl. 6, fig. 22 being anterior.

Discussion.—Proper assignment to orders of the Monoplacophora requires knowledge of the muscle scars, which this specimen fails to show. However, *Palaeacmea,* a genus of the Upper Cambrian, which has been assigned to Palaeac-

maeidae of the Tryblidioidea, is based upon *P. typica,* a species of the Potsdam sandstone; there is some doubt as to its exact position, but it is not above the *Conaspis* beds or below the *Crepicephalus* zone. Muscle scars are unknown in that species also, so the genus at least is a suitable repository for this odd little species.

Type and occurrence.—Holotype, no. 1183, collection of the writer, from the Smith Basin limestone, from the section just east of Smith Basin, New York.

Archinacella magna Flower, n. sp.

Pl. 6, fig. 12, 13

This shell is in form typical of the genus, and is a large species, the type 57 mm long, with an anterior gently curved beak, seemingly rather blunt, the aperture oval, broadly rounded posteriorly in cross section and narrowed anteriorly, the shell 39 mm wide, and 24 mm high. There are faint rather coarse growth lines. The shell shows a broad depression traversing the posterior side, but obscure anteriorly near the beak.

Discussion.—The size and proportions distinguish this form. Oddly, shells of equivalent age and somewhat similar aspect, show very different musculature, and are thus assigned to other genera; Kobayashi's (1933) *Proplina ampla* of the Wanwankou limestone of Manchuria, is a slightly smaller shell, of somewhat different proportions; Musculature is not shown or described, and it may be that this generic assignment is not correct. Yochelson suggests assignment to *Cyrtonellopsis.* Yochelson (1958) has described some approximately similar forms, but their musculature is well shown, of these *Cyrtonellopsis,* a broader and shorter shell, is from the Gasconade dolomite; from the same formation is *Bipulvina croftsae* Yochelson, a genus which shows five pairs of muscle scars. Our form is more similar to much younger species of *Archinacella* in general aspect as well as in the apparent muscle impression, than to *Cyrtonellopsis,* a genus for which muscle impressions are not known. If our shell was not reduced in thickness by solution, which is quite possible, our present apparent muscle impression could as well have been a depression of the shell which was external as well as internal.

Holotype.—No. 1175, collection of the writer, from the Smith Basin limestone, from the type section, just east of Smith Basin, New York.

Archinacella parva Flower, n. sp.

Pl. 6, fig. 14-16

This is a small shell, typical of the genus in form, with a rather narrow slender apex, low poorly defined rounded broad concentric ridges and depressions, which it is difficult to identify with certainty as either growth lines or muscle impressions; certainly growth lines are involved, but one broad depression could be a muscle impression. The shell is small, 5 mm high, 11 mm long and 7 mm wide.

Discussion.—I have questioned whether this small form might be an immature individual of *Archinacella magna.* If so, proportions change materially with growth; in this form the posterior margin is less inflated in outline, and the beak is narrow, but the anterior margin is less narrowly rounded.

Holotype.—No. 1176, collection of the writer, from the Smith Basin limestone, just east of Smith Basin, New York.

TRILOBITA

Remopleuridella? *obtusa* n. sp.

Pl. 6, Fig. 5-11

This is a rather puzzling remopleurid, the glabella convex behind, sides widening gently, gently convex, to the anterior limit of the eyes, then constricted, actually the sides concave in front of the limit of the eyes, rounding, the anterior end slightly flattened, giving the glabella an obscurely hexagonal outline. The eyes are short for a remopleurid, slightly convex, and diverge gently anteriorly. The type preserves nine thoracic segments, the last ones incomplete, but lacks a pygidium.

The holotype has a glabella 9 mm long, length and width equal, with the eyes only 4 mm long. Several additional glabella are known, but add little additional information. Glabellar furrows are not evident.

Discussion.—Though this form is referred to *Remopleuridella* there are features here which might reasonably be used for erecting a new genus. The eyes are unusually short for *Remopleurides* or *Remopleuridella,* and they fail to curve enough so that they approach each other anteriorly. The glabella is far larger and broader then in either of these genera.

Types and occurrence.—Holotype no. 1164, paratypes 1165-1168. Collection of the writer. All are from the Smith Basin limestone, just east of Smith Basin, New York.

PARAPLETHOPELTIS Bridge and Cloud

Genotype: *Paraplethopeltis obesa* Bridge and Cloud

Paraplethopeltis Bridge and Cloud, 1947, Amer. Jour. Sci., vol. 245, p. 555.

——— Hintze, 1952, Utah Geol. Min. Surv., Bull. 48, p. 201.

This genus of the Gasconade and its equivalents resembles the Trempealeauan genus *Plethopeltis,* of which it is in all probability a descendant. The border is absent or represented by a faint raised line at the extreme anterior margin of the head in typical specimens, though Hintze has referred to the genus with doubt two species from the Canadian of Utah in which well-developed brims are found. The preglabellar field is smooth, convex, featureless. The glabella is smooth and rounded, varying somewhat in shape being narrow in front in some forms, subquadrate and parallel-sided in others. The glabella bears a very faint median longitudinal ridge. Glabellar furrows and lobes are so faint that they cannot be counted. The occipital furrow is vestigial, and the occipital ring is plainly incorporated in the posterior part of the glabella, which projects backward farther than the rest of the head.

The genus appears to be particularly characteristic of the upper part of the Gasconade and its equivalents. Hintze's somewhat atypical species occur in this part of the column.

Paraplethopeltis carinifera n. sp.

Plate 6, fig. 1, 2, 3, 4, 19, 34

Cranidium with broadly rounded anterior margin, with a faint ridge sometimes visible at the extreme anterior border. Cranidium nearly as broad as long, length in holotype 8.3 mm; width across posterior limbs 8.2 mm; across palpebral lobes 6.5 mm. Glabella broadest at base of posterior limbs, width 3.2 mm, length 5.5 mm, dorsal furrow deep, rounded in front, the sides slightly convex and diverging gently backward to the posterior end of the posterior limb. Posterior margin broadly rounded, projecting backward one fifth the total length of the glabella. On this portion is an extremely faint transverse impression, all that is left of the occipital furrow. No occipital spine is developed. The midlength of the glabella is marked by a faint longitudinal ridge. Palpebral lobes with anterior margin nearly straight, extending obliquely outward, posterior side strongly rounded; lobes little elevated above the remainder of the free cheek. Posterior limbs narrowing distally, but with ends broadly rounded. The marginal furrow causes the posterior border to narrow as the glabella is approached, finally cutting it off from the glabella.

A free cheek, 9 mm in length, assigned to this species, bears a spine 6 mm long. Externally the cheek is smooth and has a convex surface similar to that of the preglabellar field of the cranidium.

Pygidium with a very narrow border, axis tapering strongly backward, dorsal furrows mainly prominent, but becoming faint at the posterior end where they enclose the axis. Axis with five prominent segments and a posterior unsegmented portion. Lateral segments with the first narrow and simple, the next two with median pleural furrows, posterior portion with faint furrows in which the pleural and interpleural pleural divisions cannot be distinguished. Very faint nodes mark the middle of the second to fourth axial segments.

Discussion.—*P. carinifera* is distinguished from *P. obesa* and *P. depressa* by the very wide preglabellar field, the somewhat broader cranidium, the backward projecting posterior margin of the glabella, and the obsolescent occipital furrow and apparently originally broad occipital ring. The faint pustules on the axis of the pygidium are also characteristic.

The two species *P. obesa* and *P. depressa* from the Tanyard formation of Texas are the only ones described which are typical of *Paraplethopeltis, P. genacurvis* and *P. renerectus* Hintze (1952) were placed in the genus with doubt because of the anterior brim. Their material also shows a faint ocular ridge. Hintze suggested that inasmuch as the typical material consisted of impressions of the interior of the glabella, these differences may be more apparent than real. This may be true of some species, but we have had enough material in limestone, preserving parts of the test and impressions of both the interior and exterior, to show that our form has no brim comparable to those of Hintze's specimens. Berg and Ross (1959) have considered the Utah forms to be hystricurids.

Occurrence.—From the Great Meadows formation and its equivalents in eastern New York and Vermont. The types are from the upper member of the Great Meadows formation, the Smith Basin limestone, where this form is particularly abundant, from the section just east of Smith Basin. The species has been found, however, in every outcrop of the Fort Ann limestone where at all extensive collecting has been done. It is present in the upper part, at least, of the Shelburne Marble of the Shorham section of Vermont. I have found it in limestone lenses in the upper part of the Great Meadows formation, notably at the Wood farm and rarely in cherts in upper dolomites of the Great Meadows formation.

Types.—Collection of the writer. These consist of the holotype, a small cranidium, no. 1169, paratypes of (1) a much larger but imperfect cranidium, no. 1170, (2-3) two free cheeks attributed to the species nos. 1174-1175, (4-5) two pygidia, one large and imperfect, no. 1172, the other smaller and exceptionally well preserved, no. 1173.

Leiocoryphe? lobata Flower, n. sp.

Pl. 6, fig. 20, 21

Only cranidia of this form have been recognized. They are smooth, round, well elevated, nearly a portion of a globe. The side and front margins are straight, the posterior margin steeply inclined, the sides excavate between a broad blunt median protuberance, and rounded lateral angles. There is no sign of eyes or of the facial suture.

The type is a cranidium 8 mm. in both length and width, 6 mm. in height.

Discussion.—This is a species easily recognized in the fauna in which it is found, but all of these extremely smooth rounded stenopilids, are extremely hard to tell apart. The form of the posterior margin of the head indicates assignment of this species to *Leiocoryphe,* rather than to *Stenopilus,* but more and better material may well show that this species should be set aside as a new genus, particularly since both *Stenopilus* and *Leiocoryphe* are Cambrian genera, and in general, Cambrian and Gasconade genera of trilobites have been found to be distinct. It may be noted that *Lieocoryphe gemma* has the median convexity on the posterior of the head much wider and less pointed when viewed from the posterior, the excavations on its sides are broader, and deepest near the media projection.

Similar globose-headed trilobites seem to have escaped description in American Gasconadian faunas. Kobayashi (1933) has described somewhat similar forms from the Wanwanian of Manchuria as *Kinstonia semicircularis, K. convexa,* and *Stenopilus convesus.*

Type and occurrence.—Holotype, collection of the writer, no. 1180, from the Smith Basin limestone, from the section just east of Smith Basin, New York.

PART III

FOSSILS FROM THE FORT ANN FORMATION

Abstract

Commoner fossils of the Fort Ann limestone, exclusive of the cephalopods, are described and illustrated from the southern end of the Champlain Valley. The fauna is of Middle Canadian age, five of the seven species here discussed are new.

Introduction

The Fort Ann formation consists of a lower 40′ of alternating beds of gray weathering dolomite, and of black limestone, which locally may be highly vermicular, and where worm burrows are abundant, may be a dark dolomite. A 4-6′ ledge at the top is of exceptionally pure and fine-grained limestone, and contains the earliest *Lecanospira* found in the section and *Campbelloceras* is characteristic. Succeeding beds are dominantly dolomitic, and silicious lenses or patches may contain nothing except *Lecanospira.* This interval averages 60′ thick, but its top is an erosion surface, and thickness varies.

The lower 40′ contains a fauna with abundant large gastropods 4-5″ across, but universally poorly preserved. These I had for some years called *Leseurilla,* and they are here described as *Leseurilla imperfecta.* Conspicuous here also are the cephalopods. The dominant types are two endoceroid genera, *Proendoceras,* which is straight and depressed in section, and the slightly endogastric *Clitendoceras. Bassleroceras* of the Tarphyceratidae is abundant, and represented by several species. Tarphyceratidae include *Campbelloceras, Apheoceras,* and *Seeloceras raei,* an imperfectly known species and genus; perhaps future work and better material may show this genus to be indistinguishable from *Campbelloceras.*

The forms here described are:

Leseurilla imperfecta
Euconia sinuata
Plethospira bilineata
Plethospira subangulata
Ophileta macroconica
Hystricurus cf. *conicus Billings*
Diaphelasma cf. *oklahomeuse* Ulrich and Cooper

Descriptions

The cephalopods are described in other works now in an advanced stage of preparation, dealing also with related Endoceratida and Tarphyceratida from other regions.

Similar and, I believe, equivalent faunas occur in two other nearby regions. The fauna of the "Kirby ledge" at Beekmantown which yielded most of the fauna described by Whitfield (1889) is allied, and contains a somewhat similar cephalopod association. The fauna leaves something to be desired in the way of preservation, but species seem, for the most part, distinct. The Rochdale limestone of the southern Hudson Valley has again yielded a similar fauna, from which Dwight (1884) described some species, but a large part of the fauna remains still undescribed.

Lesueurilla imperfecta n. sp.
Pl. 7, fig. 1, 14, 16

This is a large flat gastropod, common, but generally represented by most imperfect internal molds. Shells are thick, but external surfaces do not separate well from the matrix. The spire is slightly depressed, the whorls are irregularly rounded, with a keel poorly shown on internal molds, above the point of greatest whorl width. The sides are rounded, expanding below the keel, the outer lip rounded, attaining greatest width below the center of the whorl, the bottom gently but perceptibly flattened, rounding to the umbilical suture. The bottom side of the shell is gently concave, but very nearly flat.

Discussion.—Though this is the largest, most conspicuous, and in many exposures, the most abundant fossil of the lower limestones of the Ft. Ann formation, specimens are always poorly preserved as to exterior, often only one side of the shell is preserved, and we have found no good exteriors showing growth lines. This form is particularly common in the basal 30′, of the Fort Ann limestone, below the massive layer with *Campbelloceras* and the first *Lecanospira.*

Types and occurrence.—Holotype no. 1161, paratypes nos. 1162, 1163, collection of the writer, from the Fort Ann formation, from the section just east of Smith Basin.

Euconia sinuata n. sp.
Pl. 6, fig. 30, 31

This is a small trochiform species, the pleural angle prominently smaller in the initial part than in later portions of the shell, increasing with growth from 55 to 70°. The type is a fragment with the apex missing, 22 mm wide and 12 mm high, consisting of parts of three whorls. With the restored apex, the height would be about 20 mm. Sutures are strongly incised. Between the sutures the surface is sinuate, slightly convex, above, slightly concave below, and terminating just above the suture with a faintly projecting ridge. Growth lines swing sinuately backward from the upper suture to this outer angle, which apparently bore a slit, the exact extent of which is, however, not evident from any of our material. The base is not exposed. Our material suggests that the base was nearly flat.

Discussion.—The change in the pleural angle, small size, and sinuate outer surface will characterize this species. The shell has the proportions of a Euconia. The adoral more rapidly expanding portion approaches, though only remotely, the proportions of a true *Ophileta.*

Holotype.—Collection of the writer, no. 1184.

Occurrence.—From the Fort Ann limestone, section just east of Smith Basin, New York.

PLETHOSPIRA Ulrich 1897

Moderately high-spired, with the whorl quite attenuated below, broadcast in the upper third, where a slit, often marked by two bands, may be evident. The type is from the Fort Cassin beds of the Champlain Valley, *P. cassina* (Whitfield). Heller (1954) has added *P. extensa* from the Roubidoux of Missouri. The genus is known to range from Demingian through Cassinian faunas.

Plethospira bilineata n. sp.
Pl. 7, fig. 2, 3

The type is an internal mold showing three whorls, the apex incomplete. The outer whorl covers the lower two thirds of the preceeding whorl whorls are rounded above, attenuated below. The type is 22 mm high, 15 mm across, with the last whorl 15 mm high and 9 mm wide. Slight crushing has flattened the shell, but not seriously. The slit is slightly lower in proportion on the whorl than in *P. cassina,* which has the last whorl more prolonged below. *P. extensa* shows a whorl more evenly rounded, and less prolonged below.

Type and occurrence.—The holotype, no. 1155, in the collection of the writer, is from the Fort Ann formation, from the section along the main road leading east from Smith Basin, N. Y.

Plethospira subangulata n. sp.
Pl. 6, fig. 36; Pl. 7, fig. 9, 10

The type is an internal mold showing three whorls, the apex being incomplete. The shell is 50 mm high with about the lower 10 mm of the last half whorl missing, about 45 mm across, the aperture being obscure. The last whorl is 35 mm wide and 30 mm high, the greatest width one third the distance from the top to the bottom, where there is an obscure angulation. The profile of the last whorl is convex below the keel, then becomes straight and finally very faintly concave. The last whorl meets the preceeding one well below the keel.

Discussion.—In aspect this species has much the general appearance of the dominantly Lower Canadian *Sinuopea,* a genus similar in aspect and outline above to *Plethospira,* but in which the whorl is much shorter below the sinus. Indeed, in size our form resembles *Sinuopea regalis* Ulrich of the Gasconade of Missouri except for the prolongation of the lower part of the whorl, and suggests that there may be a real and close relationship between *Sinuopea* and *Plethospira.*

Type and occurrence.—The holotype, no. 1156 in the collection of the writer, as from the Fort Ann formation, from

the section just east of Smith Basin, New York. The species is not uncommon but commonly fails to separate well from the matrix.

OPHILETA Vanuxem

Ophileta is a low conical shell with the upper ramp fairly flat, so that the upper surface is a low broad cone. There is a sharp outer angle, which bears a sinus, below which the outer lip slopes strongly back, rounding below, and embracing part of the preceeding whorl to varying degrees.

Ozarkispira, treated as a subgenus of *Ophileta* in the Treatise, has more gently enlarging whorls which are higher. *Roubidouxia* Butts, 1926, seems little more than a rather large *Ophileta,* with the sutural ramp similarly flattened, so that the shell shows a similar fairly smooth conical upper surface, though the Treatise regards *Roubidouxia* as a synonym instead of *Schizopea,* based upon *S. washburnensis* of the Copper Ridge dolomite of Alabama, in which the upper ramp is markedly convex rather than flattened between the sutures. Certainly the Middle Canadian forms here treated are more like *Ophileta.* A third genus to be considered in relation to these species is *Rhombella.* This is also a fairly smooth cone on top, but the sutural ramp is more convex, below the outer angle, the bottom is nearly straight and horizontal, and the whorl is definitely rhomboid in section, the under side turning abruptly to form the inner lip, rather than being gently curved.

Ophileta macroconica, n. sp.
Pl. 7, fig. 11-13, 15

This shell has a low conical spire with an angle of about 120°. The dorsal surface of the internal mold shows on the type three whorls, but the complete shell was probably of four to four and a half whorls. The sutural ramp is nearly flat, but on the internal mold is very slightly convex centrally, descending very slightly and somewhat variably to the sutures. The outer angle is sharp, about 50°, the under side slightly convex, approaching the center of the whorl, curving, convex, at first gently, then strongly rounded on the umbilical region. The type shows a shell 50 mm across, about 20 mm high, allowing for the poorly preserved apex. At the anterior end the whorl is 18 mm wide, 10 mm high, and shows a dorsal ramp of 10 mm.

A paratype shows a later growth stage, though it is most incomplete, which would increase the diameter of the shell to about 60 mm and add another half whorl to the shell. The sutural ramp shows growth lines extending back from the suture to the outer angle. A third smaller imperfect shell is figured (Pl. 7, 15) which is 40 mm across, with the early whorls missing.

Discussion.—The oblique and curved under surface of the whorl instead of a flat transverse surface, places this species in *Ophileta* rather than with dominantly Middle Canadian *Rhombella.*

Our several specimens are all rather rough internal molds, and are somewhat distorted, evidently from the tectonic stresses the rock has suffered in the region. The species is nevertheless a large and characteristic one and not uncommon, though surfaces leave much to be desired.

Types and occurrence.—The holotype, no. 1158, and two paratypes, nos. 1159 and 1160 in the collection of the writer, are from the Fort Ann limestone, from the section just east of Smith Basin, N. Y.

Hystricurus cf. *conicus* (Billings)
Pl. 7, fig. 4

Bathyurus conicus Billings, 1859, Canadian Nat., Geol., vol. 4, p. 266, fig. 12d.
———— Whiteld, 1889. Amer. Mus. Nat. Hist., Bull., vol. 2, p. 61, pl. 3, fig. 15-21.

Under this designation is figured a *Hystricurus* head which is allied, at least, to Billings' species, which has probably been too broadly identified. It is of interest to note that Whitfield identified as that species a head quite similar to the one here figured, from the "Calciferous" near Beekmantown, New York, where a fauna closely allied to that of the Fort Ann formation is found in what is the rather obscure type section of the "Beekmantown" formation. With refinements of specific differentiation, and species recently described from other regions, we do not regard our specific identification as definitive. The species, though not uncommon, is almost invariably poorly preserved.

Figured specimen.—Collection of the writer, no. 1157. From the Fort Ann limestone, from the section just east of Smith Basin, N.Y.

Diaphelasma cf. *oklahomense* Ulrich and Cooper
Pl. 7, fig. 5-8

The lower 40′ of the Fort Ann formation contain a moderately small shell of syntrophiid aspect, with a narrow margin and a sharp fold and sulcus. Though the form is abundant, most specimens are only most poorly preserved. The figured specimen is an internal mold of a specimen with both valves, 10 mm long, 7 mm wide, 6 mm high, with a sulcus 4 mm high and 6 mm wide. The internal features of the beak are those of the Clarkellidae; the general proportions with the deep fold and sulcus, and general form are typical of *Diaphelasma.*

Discussion.—The determination of this form as closely allied to *Diaphelasma oklahomense* is not mine, but that of Dr. G. A. Cooper, without whose help I would have been uncertain of even the genus. It is worth noting here that *Diaphelasma* is a genus widespread in North America and characteristic of the Middle Canadian. Ulrich and Cooper (1938) call attention to a form from the Ogdenburg dolomite of northwestern New York, in which are included both Middle Canadian and some beds of Jeffersonian age. *D. quebecense* occurs in the Hastings Creek limestone of the Phillipsburg region of Quebec; this is Middle Canadian from the endoceroids, not Lower Canadian or upper Ozarkian as formerly stated. In the higher Luke Hill limestone *D. breviseptatum* is found. *D. pennsylvanicum* of the Longview limestone continues representation of the genus into the Appalachian region and Sando (1957) has added *D. marylandicum* and *D. subquadratum* from the Rochdale Run formation of Maryland. In Oklahoma *D. oklahomense* Ulrich and Cooper occurs in the Cool Creek formation. The Gorman of Central Texas has yielded *Diaphelasma okahomense* and *D. pennsyl-*

vanicum (Cloud 1948). The El Paso group has yielded *D.* cf. *pennsylvanicum* in the Cooks formation and *D. cf. complanatum* in the Victorio formation, and the latter species has been recognized (Hintze and Jensen, in conversation) in the fauna of the first piloceroid zone which occurs in zone E of the Fillmore limestone of western Utah. *Diaphelasma complanatum* was first described from the Manitou limestone of Colorado.

Figured specimen.—Collection of the writer, no. 1215, from the lower 40′ of the Fort Ann formation, from the section just east of Smith Basin, New York.

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PART IV

MEROSTOMES FROM A COTTER HORIZON OF THE EL PASO GROUP

Abstract

Silicified merostomes recovered from a faunule of Cotter age in the lower part of the Scenic Drive formation of the El Paso group constitute four species of the new genus *Lemoneites,* which combines some features known previously in the Aglaspida with others known previously only in some of the Synziphosura. The new family Lemoneitidae is proposed. Affinities of the genus and its bearing on arthropod classification are discussed.

Introduction

Here are described some tiny merostomes retrieved from the fine etching from a dolomite containing silicified fossils in the Cassinian part of the El Paso group. The occurrence, discussed in more detail below, lies in the lower part of the Scenic Drive formation (Flower 1964), of the El Paso group of the southern Franklin Mountains. The presence of *Ceratopea ankylosa* identified by Dr. Ellis Yochelson, indicates equivalence of the bed with the Cotter of the Ozark uplift.

These specimens, eight of which were retrieved, are remarkable in several respects. They are, to my limited knowledge, the first merostomes to be found silicified and etched from a dolomite. They show considerable relief, not shown by most material by which most of the previously known the Aglaspida and Synziphosura are represented. Indeed, most known specimens of both groups have been found flattened, with much of the integument dissolved, and particularly in the Synziphosura, the remains are too generally carbonaceous impressions of scant relief, in which features of the lower and upper surfaces of the dorsal carapace have been merged, a matter which has quite possibly been a source of some confusion in interpreting the morphology of these forms. Morphologically, these new forms combine some features of the Aglaspida with some of the Synziphosura, and thus tend to reduce the morphological gap which before seemed to separate these groups quite widely. The specimens, occurring in beds of Cotter age, in the Upper Canadian, lie within the previously known range of the aglaspids, which range from *Paleomerus* Størmer (1955-6) of the Lower Cambrian to *Neostrabops* Caster and Macke 1952 in the Upper Ordovician. However, *Neostrabops* is still known from a single species and a single specimen, is the only known record of the order above the Upper Cambrian, and the group is known mainly from a concentration of forms, (Raasch, 1939) from the Trempealeauan of the northern Mississippi Valley. The oldest previously reported Synziphosura are of Upper Silurian age, occurring in the Salina group of eastern North America, and in the Downtonian of Great Britain and the Baltic region.

ACKNOWLEDGEMENTS

I am indebted to Dr. David LeMone of Texas Western University for aid in collecting; elsewhere he will present a revised section of the El Paso Group at its type section, in the southern Franklin Mountains, at the edge of El Paso, Texas.

Miss Michaele Huygen, for some years my assistant, has also aided materially in collecting, etching and sorting the materials which yielded the specimens here described, as well as in photography.

For some suggestions and discussion of some problems of arthropod phylogeny, I am indebted to Dr. Leif Størmer, of the University of Oslo, whose work has done so much to clarify arthropod relationships in the Paleozoic.

Dr. Ellis Yochelson has contributed materially in the identification of associated gastropods and thus to the dating of the bed yielding these fossils.

Descriptions

Genus *LEMONEITES* Flower, n. gen.

Genotype: *Lemoneites mirabilis* Flower, n. sp.

This genus is erected for remarkable merostomes of the Canadian, combining some aglaspid and some synziphosuran features. The prosoma is small, about one fourth the total length of the carapace, gently arched, semicircular or slightly broader than long, the front smoothly rounded, the posterior margin transverse or faintly concave, with a faint groove and a posterior border. It is smooth except for quite small eyes moderately separated, and located at about midlength. There follow eight simple body segments, the carapace widening slightly behind the prosoma to the third segment, then narrowing and followed by three more segments, progressive in showing extreme narrowing and elongation. Each segment consists of a low anterior raised ring, which presumably fitted under the posterior of the preceding segment, a narrow median depressed region, and a posterior ring, larger and higher than the anterior one. The telson narrows beyond the base, then enlarges, and is rod-like or club-shaped beyond, and may bear wrinkles or pustules. The dorsal rings of the last three body segments may continue partly or completely across the ventral surface. The anterior end of the specimens shows a rostrum-like structure below, unknown in previously described Aglaspida or Xiphosurida, but known is some Trilobitomorpha. This fact should not be emphasized; ventral surfaces of merostemes are most incompletely known; in fact our ignorance of them, outside of the Eurypterida is staggering.

Discussion.—The affinities of this genus are discussed at length following the description of the species. It will suffice here to note that there is no merostome genus which resembles this one closely. The most peculiar feature is the form of the body segments, each with a raised anterior ring, a median transverse depression, a larger higher posterior ring beneath which fits the anterior ring of the next following segment. In general proportions, and in particular in the small semicircular prosoma, the genus is most closely approached by *Strabops;* likewise that genus has a telson constricted at or near its base. However, an important difference is found in the eyes, which in *Lemoneites* are tiny, obscure in contrast to those of the aglaspids, and located at midlength rather than anteriorly on the prosoma. The specialization of the last three posterior body segments which show progressive narrowing and elongation, finds a parallel in *Limuloides* and *Bunoides,* but has not been found in any previously known aglaspids. The ornamentation of the telson is unlike that of any other known merostomes, but is again comparable, though different specializations are found, to that of *Limuloides* and *Bunoides,* in the Synziphosura.

The genus is so far known only from the species described below, or Upper Canadian age, and is named for Dr. David LeMone, in recognition both of his help in collecting and of his independent investigations of the El Paso Group.

Lemoneites mirabilis Flower, n. sp.

Pl. 8, fig. 1-4

The holotype is a nearly complete dorsal carapace, showing some damage to the prosoma. It is uncertain that the telson is complete. The prosoma is semicircular, rounded in front, with some irregularities which are apparently adventitious, the posterior margin straight and transverse, the length half the width, with two small eyes; otherwise the dorsal surface is smooth, except for a faint groove and a posterior slightly raised border. Of the eleven body segments, the first eight are simple, without trilobation, the body widening from the prosoma to the third segment, then narrowing. The ninth segment shows some enlargement of the posterior ring and the anterior ring, less enlarged, is widened centrally. The next two segments show progressive accentuation of the median depression and enlargement of the posterior ring. The telson narrows slightly beyond its base, so that it too has a low anterior ring; the remainder expands slightly, and is rod-like rather than club-shaped, with some curious lateral wrinkles, and a raised transverse band across the dorsum near its apparent tip. The tip is transverse and blunt, and may not be quite complete. The underside of the specimen shows the anterior part covered with adventitious silica, but there is a large rostrum-like anterior structure. The three posterior segments show the rings of the dorsum partly surrounding a smooth ventral surface, beyond which the telson shows no markings on the ventral surface. The type is 13.5 mm long, 6 mm wide, with a prosoma 3 mm long, 5.5 mm wide, and a telson 3.6 mm long.

Discussion.—The shape of the prosoma, the form of the three posterior body segments and that of the telson distinguish this species. In *L. simplex* the prosoma is more rounded anteriorly, the last three segments show less marked elongation, the rings continue across the venter there, and the telson is faintly club-shaped and without apparent markings. In *L. gomphocaudatus* the telson is club-shaped and pustulose, and the last three segments are less specialized, *L. ambiguus* is a somewhat larger form with the posterior margin of the prosoma concave, the posterior three body segments are imperfectly known, and the telson has not yet been obserbed. Some markings at the prosoma and the incomplete condition of the anterior margin are plainly adventitious.

The wrinklings of the telson suggest the possibility of its derivation from a true telson with which are fused two or more body segments. The lateral view, however suggests that this iconoclastic conclusion is wrong, and that the wrinkling is a specialization analogous to the tubercles in *L. gomphocaudatus.*

Holotype.—No. 1207, Collection of the writer, New Mexico Bureau of Mines, Socorro, N.M.

Lemoneites cf. *mirabilis* Flower

Pl. 9, fig. 13-15

This specimen, tentatively assigned to *L. mirabilis,* is a

mere scrap showing only part of the telson and the three posterior body segments. The anterior end is covered by adventitious silica. It is illustrated as the only other specimen assignable to the species so far known. The figured specimen is no. 1208. Note the incompleteness of the posterior rings in fig. 13. The specimen is 8 mm long, and obviously represents a fragment of a considerably larger individual then the holotype of *L. mirabilis.*

Lemoneites simplex Flower, n. sp.
Pl. 8, fig. 10-13

The prosoma of this species is somewhat more broadly rounded anteriorly than is that of *L. mirabilis,* with the length slightly greater than half the width, and more evenly rounded in profile anteriorly. The eyes are small and obscure, the posterior border extremely faintly elevated. On the type the eight anterior body segements seem simple, because the low anterior ring of one segment lies below the larger posterior ring of the preceding segment. As in *L. mirabilis,* the body widens from the prosoma to the third segment, and then narrows. The last three segments show narrowing, elongation, and increased prominence of the anterior and posterior rings, but the specialization is less advanced than in *L. mirabilis.* The telson seems tubular in dorsal view, with the narrowing beyond the base very slight, but in lateral view it is slightly clavate, widening beyond the basal constriction, and then narrowing gently to a blunt termination which may not be actually complete. The under surface shows an irregular anterior suggestion of a rostrum-like body. The main part of the body is obscured by accessory silica, but it is clear that the rings of the last three segments continue unbroken across the ventral surface. The telson is simple below.

The single type is no. 1209. It is 11 mm long, 5.5 mm wide, with a prosoma 3.5 mm long, 5.5 mm wide, and a telson 3.2 mm long.

Lemoneites gomphocaudatus Flower, n. sp.
Pl. 8, fig. 5-9; Pl. 9, fig. 1-5, 11, 12

The holotype is a nearly complete carapace, but with some damage, the right lateral part of some of the body segments is bent over the middle part of the dorsum. The prosoma is between one-fourth and one-fifth the total length, the anterior end smoothly rounded, the posterior part transverse, with the border faintly differentiated; eyes are small and obscure. Silicifiation has left the prosoma with some adventitious pitting. The length is half the width. The anterior eight body segments are somewhat obscure, the specialization of the last three segments is more obvious in lateral than in dorsal view. Though progressive elongation of the last three segments is less extreme then in *L. mirabilis,* the enlargement of the posterior ring is marked. The telson narrows beyond its base, then swells to a club-shaped structure, narrowing conically to a blunt tip. The dorsal and lateral surfaces bear large pustules, arranged in a bilaterally symmetrical pattern, as can be seen from the illustrations. The type is 11 mm long and 5.5 mm wide, with a prosoma 3.5 mm long and 5.5 mm wide; the entire width of the body was probably 6 mm; the telson is 3.2 mm long.

A paratype, (Pl. 1, fig. 5-9) consists of a telson, the posterior three specialized segments, and parts of seven anterior segments. This is a slightly smaller individual, but it shows essentially the same features, as far as the preserved parts go, as does the holotype. The venter of the holotype shows a suggestion of a rostrum-like structure. The condition of the rings of the three posterior body segments across the venter is ambiguous in the holotype. In the paratype, however, it is clear that the posterior ring of at least the last segment extends across the venter, and the obscurity of the rings in the preceding two segments is reasonably attributed to phenomena of preservation. The specimen is 7 mm long and 3.5 mm wide.

Types.—Holotype, no. 1210, paratype, no. 1211, collection of the writer.

Lemoneites cf. *gomphocaudatus*
Pl. 9, fig. 11, 12

Under this designation is figured a posterior fragment of a *Lemoneites,* showing a slightly less inflated club-shaped telson, three anterior segments, comparable to those of *L. gomphocaudatus,* and on the dorsum, four additional body segments are recognizable, with some silica obscuring anterior segments. While comparable to *L. gomphocaudatus,* it is not strictly identical, and is evidently from a form having a considerably more slender body. The figured specimen is no. 1212; it is 6 mm long and 2.5 mm wide.

Lemoneites ambiguus Flower, n. sp.
Pl. 8, fig. 6, 7; Pl. 9, fig. 16-17

This is a species represented by two specimens, both slightly larger than the forms described above. The two specimens show a prosoma, each with the posterior margin with a border, but slightly concave rather than transverse. The paratype shows that behind the simple anterior eight body segments, there are others narrowed, elongated, with exaggeration of the anterior and posterior rings, but only the first of these segments is known, the other two and the telson have not yet been found.

The holotype shows a good prosoma, the median length slightly more than one-third the width; owing to the concavity of the posterior margin, the total length is almost exactly half the width. Eyes are present, but of low relief; there is a posterior border. The holotype preserves seven body segments; the anterior rings are enclosed by the posterior rings of preceding segments. It is 8 mm long, 6.5 mm wide, with a prosoma 3 mm long at the middle, with a total length of 3.5 mm, and a width of 6.5 mm.

A paratype, a slightly smaller individual, with the left side of the prosoma displaced in preparation, shows in addition one narrowed and elongated posterior body segment, and below is shown a rostrumlike process. It is 7 mm long and 5.5 mm wide, with a prosoma 2.5 mm long and 5.5 mm wide.

Discussion.—We have as yet no posterior parts which can be attributed reasonably to this species. The posterior part attributed to *L. gomphocaudatus* is narrow for that species, and its narrowness makes it even less convincing when attribution to this broader form is attempted. Future finds may show this form to be distinctive enough to be set apart in a new genus, but no such step is justified by the material now at hand.

Types.—The holotype, no. 1213, and the paratype, no. 1214, are in the collection of the writer.

Affinities of Lemoneites

Lemoneites seems to combine some features of the aglaspids with others of the Synziphosura. Previously known aglaspids are largely confined to the Trempealeauan of the northern Mississippi Valley, though Størmer (1956) has described the remarkable genus *Paleomerus* from the Lower Cambrian of Sweden, and Caster and Macke (1952) have described *Neostrabops* which is still known from one specimen, from the Corryville division of the Maysville, of the Upper Ordovician of the Cincinnati region.

The Synziphosura, on the other hand, are known from specimens ranging up from the Upper Silurian, the Salina group of North America and the Downtonian of Europe, into the Devonian, at which point they seemingly merge with the Limulava, the Xiphosura of older works.

While arthropods with chitin fortified by calcium carbonate or other material (notably the trilobites and the ostracodes), prevail in the Paleozoic, forms with primitive chitin are not commonly preserved. We know the Trilobitomorpha exclusively from the Burgess Shale, an environment of preservation which has not yet been duplicated. We know the Aglaspida mainly from the shales and siltstones of the Trempealeauan of the northern Mississippi Valley. We know the Silurian Synziphosura from shales and waterlimes, which are specialized environments of preservation. Though they are marine, molluscs are reduced to impression material, with not even a calcitic replacement of the shells; yet both the Vernon and the Bertie have yielded significant marine assemblages, including cephalopods and brachiopods, which are unknown in fresh or even brackish water associations. Nevertheless, there was something special about these environments, though we cannot say exactly what, which leaves them preserving eurypterids, Synziphosura, and fishes. The merostomes, including both the eurypterids and the rarer synziphosurans, are represented largely by flattened carbonaceous impressions; some are of scant relief, none are of appreciable thickness except for the Baltic genus *Bunodes* (Størmer, *fide litt.*). Under such conditions of preservation, features of the dorsal exterior and of the dorsal interior are merged and fused. This fact has, I believe, been overlooked, and from such material there has resulted a concept of a group of disparate genera, varying to a confusing extent. Some show features, variously interpreted, but surely in a large part having to do with the insertion of leg-muscles on the dorsal interior; these have been upon occasion confused with the development of a "cardiac lobe," which is developed certainly only in the younger Limulava. Another curious point has been encountered. The Synziphosura have been considered as eyeless, a condition I would question. If they are the link between the dominately Cambrian Aglaspida, and the dominantly Late Paleozoic Limulava, both of which possess good compound eyes, they must have had eyes also. If they do not supply such a link, no other connection is known. I would suggest that the supposed absence of compound eyes in the Synziphosura must surely be adventitious, the result of failure of eyes of low relief to be preserved, while features of the dorsal interior of the carapace, having greater relief, have become merged with the dorsal surface in many of the described specimens.

The vagaries attending the preservation of chitin are not yet fully understood, but they certainly leave us with a sadly inadequate record of the primitive arthropods, both of the mandibulate and of the chelicerate lines. It cannot be hoped that our present find, peculiar though it is in mode of preservation, in age, and in the relief shown by the specimens, which has been duplicated only in *Paleomerus* and in *Bunodes,* can supply a solution to a problem for which much evidently missing information is still badly needed.

As at present understood, the Merostomata are divided into the Xiphosurida and the Eurypterida; the Xiphosurida are divided into the orders Aglaspida (see Raasch, 1939, Størmer, 1952, 1955) and the Xiphosura, with the Xiphosura divided into the Synziphosura and the Limulava, the latter having the scope formerly given to the Xiphosura. To these have been added the Chasmataspida Caster and Brooks (1956).

The oldest member of this lineage known in the Lower Cambrian *Paleomerus* Størmer (1955, 1956) a form with 12 body segments which Størmer regards as the possible ancestor of the Eurypterida, as well as the most archaic of the known Xiphosura. There follow two other families of the aglaspids, the Aglaspidae, dominantly Upper Cambrian, and the Strabopidae, with one Upper Cambrian and one Upper Ordovician genus, and the Beckwithiidae, a family known from one Middle Cambrian genus and species.

To these are added below the family Lemoneitidae, known from one genus and four species of early Cassinian (Upper Canadian) age. The next stratigraphic occurrence is that of the Chasmataspidae, Caster and Brooks (1956) known from one genus and one species from the Canadian-Chazyan hiatus in Tennessee; possibly it belongs in the base of the Lenoir, which equates presumably with the Chazy. This is a remarkable form distinct from all others in the specialization of the anterior body segments into a buckler of some complexity. It represents a line of its own, which gave rise to nothing higher, at least nothing higher yet known.

The Synziphosura seem a bewildering group, combining forms with prosomae ranging from simple and so smooth that even eyes have not been observed, to others of considerable complexity, with advanced ornamentation of the dorsal surface as in *Limuloides,* while others show more or less radial markings, certainly features of the internal surface, having to do with attachment of leg muscles, while again in other forms there is an axial structure regarded as a cardiac lobe, a feature more typically developed in the Limulava. With many forms rare, and quite a few of them known only from rather poorly preserved material, it would seem that the present classification is questionable, but it is at present not possible to do much better. Particularly, our present genus, *Lemoneites,* in the specialization of the three posterior body segments suggests that possibly it is the ancestor to *Limuloides* and *Bunoides,* and perhaps to *Weinbergina,* but that

Bembicosoma and *Bunaia* can hardly belong with *Bunodes.* However, there are still too few genera known for one to offer a tenable phylogeny of the group, except that as a group they seemingly lie morphologically and stratigraphically between the Aglaspida and the Limulava.

Lemoneites combines some features previously known in some aglaspids with others previously found only in the Synxiphosura. The general proportions, the rather small head, the widening of the body behind the head, and later decrease in width to the telson, are similar to those of *Strabops,* and, though more remotely, to *Paleomerus* and *Neostrabops.* The fact that the prosoma is only about one fourth the length of the whole carapace is a feature found in these genera, but not in the Synziphosura or, for that matter, in the Aglaspidae. In the Synziphosura the prosoma is at the least one-third the total length, being of those proportions in *Bunodes, Limuloides* and *Bembicosoma,* while in other forms the length of the prosoma equals or exceeds that of the body segments exclusive of the telson.

The development of a posterior border is a feature known in several aglaspids, but not reported in the Synziphosura. Indeed, traces of borders surrounding the anterior as well as the posterior margin of the prosoma are found in a number of Aglaspidae, and part of an anterior border is suggested for *Strabops.* An apparent anterior border is shown in the highly ornamented prosoma of *Limuloides,* but no posterior border exists.

In possessing eleven body segments, *Lemoneites* differs from the Synziphosura and agrees with the Aglaspidae and Strabopidae of the Aglaspida. *Beckwithia* shows only eight segments, but presumably some posterior segments have become ankylosed with the telson. The genus *Paleomerus,* the only aglaspid so far known from the Lower Cambrian, has twelve segmenets. Paleozoic chelicerata could count, but not too well. Possibly their attention wandered.

The telson of *Strabops* is narrow anteriorly, widens rapidly then contracts gently toward a blunt tip. In general form, this is quite like the telson of *Lemoneites gomphocaudatus,* except that pustules are wanting, and there is no short slight anterior enlargement; this last difference may be more apparent than real; the anterior part of the telson is seemingly covered by the last body segment, in the one known specimen of *Strabops thatcheri.*

Two features of *Lemoneites* seem to be shared with the Synziphosura. The eyes are small, located at midlength. Eyes are obscure; both cannot be seen in several of our specimens, and their relief is generally such that special lighting was needed to bring them out in our photographs. As noted above, theoretical considerations suggest most strongly that the reputed eyeless condition of the Synziphosura must be adventitious if they are the phyletic link between the aglaspids and the Limulava. Elongation and specialization of the last three body segments is a feature unknown in the Aglaspida, but shown, though with different sorts of markings, in *Bunodes* and in *Limuloides,* of the Synziphosura.

The division of body segments into a low anterior ring, a median depressed zone, and a larger posterior ring, and placement of the low anterior ring below the posterior ring of the preceding segment, is a combination of features unknown in previously described aglaspids or xiphosurans. Body segments of some forms which are known only from considerably flattened material, might have such structures lost by crushing, but there is no indication of such structures in *Paleomerus* Størmer of the aglaspids, not of *Bunodes* Eichwald, both of which are known from material showing considerable relief. Likewise, while there is some ornamentation of the telson in *Limuloides* and in *Bunodes,* no merostome genus has yet been reported as showing wrinkles or pustules like those exhibited by *Lemoneites.*

No rostrum-like structure has been reported previously in the Aglaspida or in the Ziphosura. Perhaps too much emphasis should be laid upon this point, as most species are known either from crushed specimens or from dorsal exteriors. However, in the Salina and Downtonian forms, many specimens show not only crushing, but solution of much of the original test, with resultant possible confusion of features of the dorsal interior and exterior as well as of the venter. It would seem likely that in such specimens, as well as in the aglaspids known from specimens flattened in silts and shales of the Upper Cambrian, that such rostral structures would have been found if they existed there and had any appreciable thickness. Curiously, comparable structures have been reported in *Burgesia* and *Marella,* but the structures shown are not closely similar to those shown in *Lemoneites.* It is of interest to note, that while a very real phyletic gap is believed to exist between the Trilobitomorpha and the Merostomata, a gap involving some profound morphological changes, not the least of which is the incorporation of several additional body segments with the "head" without knowledge of appendages, the two groups could be readily confused, as shown by Størmer's diagram (1956, p. 512, fig. 3). There is no good reason to consider *Lemoneites* as a member of the Trilobitomorpha; its features combine those of the aglaspids and the primitive xiphosurans.

While *Lemoneites* seems to show more features in common with the aglaspids than with the Synziphosura, it nevertheless reduces the morphological gap which before seemed to separate these groups. This is not surprising in view of its stratigraphic position, which is above the main concentration of the aglaspids in the Upper Cambrian, and well below the first known appearance of the Synziphosura in the Salina of North America and the Downtonian of Europe. It therefore seems best to assign *Lemoneites* to the Aglaspida, but to place it in a family by itself, defined as follows:

Family *LEMONEITIDAE* Flower

Aglaspida with the eyes reduced greatly in size, located at midlength in an otherwise simple semicircular gently arched prosoma, eleven body segments, each with a low anterior ring and a larger posterior ring, under which the anterior ring of the following segment may be placed, the last three segments specialized, narrowed and elongated with the rings increasing in size and prominence, a telson narrowed just behind the point of articulation, then widened, club-shaped or rod-like, with an ornamentation of wrinkles and ridges or pustules or both.

Occurrence

The merostomes here described are a part of a fauna found in a 3.5-4.0′ layer of dolomite, moderately sand-free at the top, but with such abundant cross-bedded sand in the lower part that it is properly a sandy dolomite. This is found low in the Scenic Drive formation, B2b of Cloud and Barnes (1946) near the Scenic Drive at El Paso. The Scenic Drive formation there lies below the Florida formation, the highest unit of the El Paso, consisting of 36′ of limestone with abundant layers of orange-weathering silt, some calcilutite, calcareous shale, but mainly of calcarenites and rudites. Its fauna indicates correlation with the latest Canadian, zone J of the Utah region, the Odenville of Alabama, and possibly the Black Rock of Arkansas and the Providence Island of Lake Champlain.

Below this lies the Scenic Drive formation which consists of about 220′ of limestone with a fauna of Cassinian aspect, with below 60 feet of dolomite, the top with minor sand, the lower part with abundant sand. Dolomite under this interval is largely sand-free, and grades down, with also some lateral gradation in the lower part, into the limestones of the McKelligon formation.

Limestones of the Scenic Drive formation have yielded a fauna of Cassinian aspect. There is some zonation within it, not yet fully known because of the difficulty of obtaining fossils from the matrix in an identifiable condition.

The top 12′ of the dolomite contains as the upper and lower members two beds of very dark, essentially black weathering dolomite, 1.5-2.0′ thick which have yielded significant faunas of silicified fossils, mainly molluscs. The intervening beds have yielded similar fossils but in less abundance, and show considerable lithic variation as they are traced laterally. This interval has yielded *Ceratopea buttsi* and *C. hami.* As these two species were reported as in succession rather than in association in the Arbuckle limestone, (Yochelson and Bridge, 1957), the only region in which they have both been found in the later Canadian, the interval was collected again. The results show that the association is real.

Below this are lighter colored dolomites, weathering buff to gray. The upper 23′ contain only minor fine sand, but in the next 22′ below sand is abundant and conspicuous. One-eighth mile north of the Scenic Drive, 49 feet below the top of the dolomite, there is a 3.5-4.0′ bed of dolomite with coarse sand, very sandy and cross-bedded below. It is this interval, which continues for another eighth of a mile to the north, that has yielded the fauna here described. Beyond these limits, the bed becomes thinner, being reduced to 2′ at the Scenic Drive, sand content is reduced, and silicified fossils are not longer evident, aside from silicous worm borings. Where the fossils are developed, the layer of coarse sand is underlaid by a 4′ bed of massive-weathering dolomite with abundant very fine sand; the sand is concentrated in thin, very close, even layers averaging ⅛″ thick. There is some minor cross-bedding. This layer is conspicuous, and the writer had formerly taken it as the base of the Scenic Drive formation. However, when this part of the section is traced south to the Scenic Drive in an eighth of a mile, this layer disappears altogether, and it disappears again when traced to the north. It has only been seen in this short length of outcrop. Though it may well mark the true beginning of Cassinian deposition following a minor diastemic break, the boundary is one not readily recognized elsewhere, and it seems best to consider the base of the Cassinian as lying some 45′ lower in the section, at the appearance of the first significant occurrence of coarse sand in the dolomites. At the Scenic Drive this is a 1.5′ layer of dark-weathering dolomite, containing in its lower part ovoid patches of coarse russet-weathering sand in masses commonly 3-4″ high and 5-6″ across, and showing *Scolithus* borings. About 200′ farther north, this bed is mainly filled by coarse cross-bedded sandstone, and a little farther north the sand declines. Below dolomites with only minor and sparsely scattered sand grains grade downward into sand-free beds and into the limestones of the McKelligon Canyon formation.

Chance silicification is responsible for the preservation of the fauna in this one restricted lens. There is no real indication over how much of the interval from 13′ below the lens to the 12′ interval 71′ higher in the section, this fauna persisted.

In an attempt to bring some coherence to the Canadian, the writer (1957) proposed as its major divisions Gasconadian, Demingian, Jeffersonian and Cassinian. Division of the Upper Canadian into two units was based on definite evidence of onlap of the Ft. Cassin beds of the Champlain Valley on an erosion surface, largely Demingian, but containing some local beds of late Jefferson City age, and by the presence of conspicuous sand both in the basal beds of the Fort Cassin formation, and in the base of the Scenic Drive formation of the El Paso Group. The Cotter and Powell were regarded as Jeffersonian, partly because the McKelligon formation yielded piloceroids similar to forms previously known only from the Cotter equivalent in Tennessee, but in part also because this interpretation seemed reasonable from the great thickness of the McKelligon formation, and from some indications that its upper beds yielded faunas distinct from those of the main part. Cloud and Barnes (1948) record 712 of the McKelligon formation (their B1 and B2a) from 540′ to 1225′ above the base of the El Paso limestone.

It is now apparent that if the *Ceratopea* species are reliable zone markers, the Cotter equivalent occurs above the break separating Jeffersonian and Cassinian deposition, and that Cotter and Powell equivalents as well as Smithville-Ft. Cassin equivalents should be present in the Scenic Drive formation. At the present time there is no good basis for identifying the Powell equivalent; its fauna, as reported up to the present, consists of species of so far only recognized in the Ozark section, representing genera which range widely stratigraphically in the later Canadian.

The fauna of which the merostomes here described are a small part, is a large one. It was obtained by etching an extensive collection of boulders selected largely for evident fossils on the weathered surface. The upper four to six inches are relatively sand-free dolomite; the lower foot is a cross-bedded sandstone, pieces of which hold together even after

thorough etching. There is some secondary cementation of sand grains by extra silica, but this is not extensive. Throughout the formation irregular worm borings occur, which are silicified. In cleaning and sorting even with great care, the more delicate fossils were not uncommonly broken, owing to the large amount of coarse sand. The fauna so far retrieved is in the process of study, and various groups have been submitted to specialists. The forms now known may be summarized as follows:

Brachiopoda.—Specimens of this group are few, many of the shells are small and fragile, many must have been lost or broken in washing the silicious residues. Commonest are small fragile shells of the aspect of *Diparalasma*. One incomplete valve of a large syntrophid was retrieved.

Gastropoda.—This is the dominant group in the fauna. Operculae of *Ceratopea ankylosa* are abundant, and a few shells of the genus have been retrieved. Other general include *Lophonema, Rhombella, Clissospira Euconia, Hormotoma,* and a medium-sized scalariform gastropod representing an undescribed genus. I am indebted to Dr. Ellis Yochelson for these determinations.

Pelecypoda.—Shells of the aspect of *Euchasma* are not uncommon, and appear to represent a single species. They have been submitted to Dr. John Pojeta for description. This is the lowest horizon in the El Paso group that has so far yielded pelecypods.

Cephalopoda.—Ellesmeroceratidae are represented by two species of tiny *Clelandoceras*. Protocycloceratidae are present but fragmentary; Baltoceratidae are small and fragmentary, but certainly belong largely to *Cyptendoceras*. A very few fragments of endoceroid siphuncles have been found, but internal structure is too poor to justify generic determination. No Piloceratidae have been observed. Tarphyceratidae include two species of *Arkoceras* (= *Wichitoceras*) and a small *Tarphyceras*. Several small fragments of *Michelinoceras* mark the earliest position for the genus and for the order Michelinoceratida in the El Paso group. *Michelinoceras primum* Flower occurs in the limestones of the Scenic Drive formation, some 100 feet higher in the section, and with a quite different fauna.

Monoplacophora.—*Helcionopsis,* apparently one species, and a broadly conical shell with a low symmetrical cone; muscle impressions are not shown, and the generic position of this form is doubtful.

Polyplacophora.—One large plate has been retrieved.

Merostomata.—The species of *Lemoneites* here described.

Ostracoda.—This horizon is the lowest one in the El Paso group to yield ostracodes. Perhaps three dozen specimens have been retrieved from extensive etching; Dr. Jean Berdan reports that several genera are represented, but incomplete silicification leaves specimens which it is difficult to compare closely.

Trilobita.—Here again silicification is incomplete, and remains are not for the most part generically identifiable, though it is evident that several genera occur in the association.

It is possibly significant that these tiny merostomes came from a dolomite abundantly supplied with sand and conspicuously cross-bedded in which molluscs are silicified. Silicification is a process yet poorly understood, but it is clear that there is no one simple explanation. One type of silicification yields well-replaced specimens of moluscs, but trilobites, ostracodes and brachiopods are poorly replaced if at all. In contrast, another type of silicification as exemplified by Ordovician beds in Virginia, yields well preserved trilobites, ostracodes and some brachiopods, but molluscs are calcitic. It might be suggested that further finds of silicified merostomes might be made by examination of fine residues from limestones in which the molluscs are silicified. Two such associations are known, the late Wilderness limestones of the Paquette Rapids of the Ottawa River, and layers of the Tyrone limestone of Kentucky of about the same age. Though the former occurrence has been collected for years, with extensive etching, and the Tyrone association is currently under investigation by Dr. John Pojeta, merostomes have not been found in the fine residues. Possibly the merostomes, like the living *Limulus,* favored bottoms supplied with at least fine sand. Etching of the Paquette Rapids limestones yields fine black mud, the Tyrone occurrence yields a fine yellow clay mud. It may be suggested that further search of fine residues from limestones or dolomites with abundant sand may yield further finds of this nature.

It should be noted that nearly all of the specimens retrieved show some articulation of body segments. If these remains had been subject to such transportation as would be involved in removal from fresh or brackish water environments, such articulation would be likely to be lost. It therefore seems reasonable to conclude that these forms lived essentially in the marine association in which they have been found.

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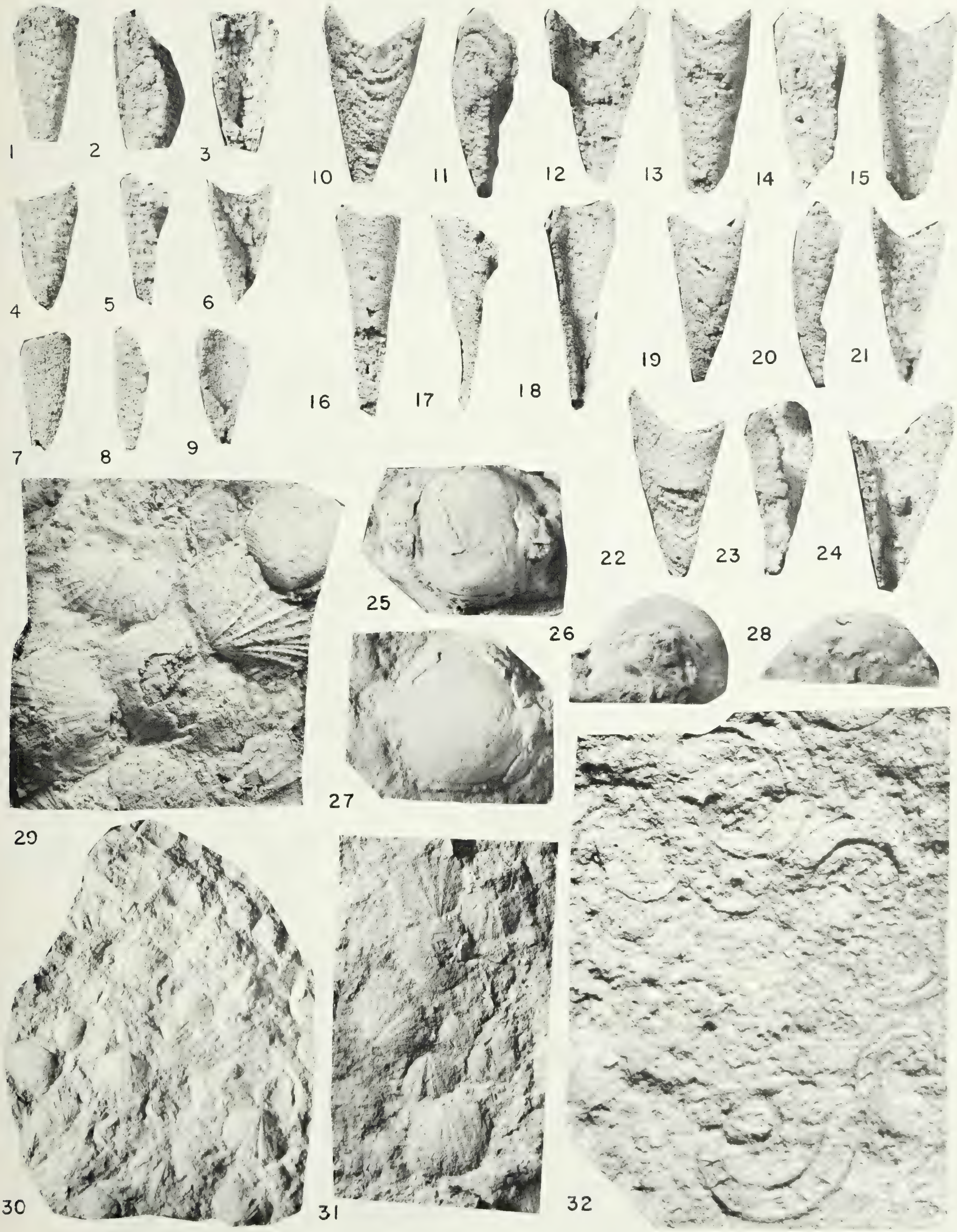
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Figs. 24-27 from 146-172′ above the base of the Paleozoic, Mescal Canyon, Big Hatchet Mountains; here regarded as lower El Paso rather than Bliss.

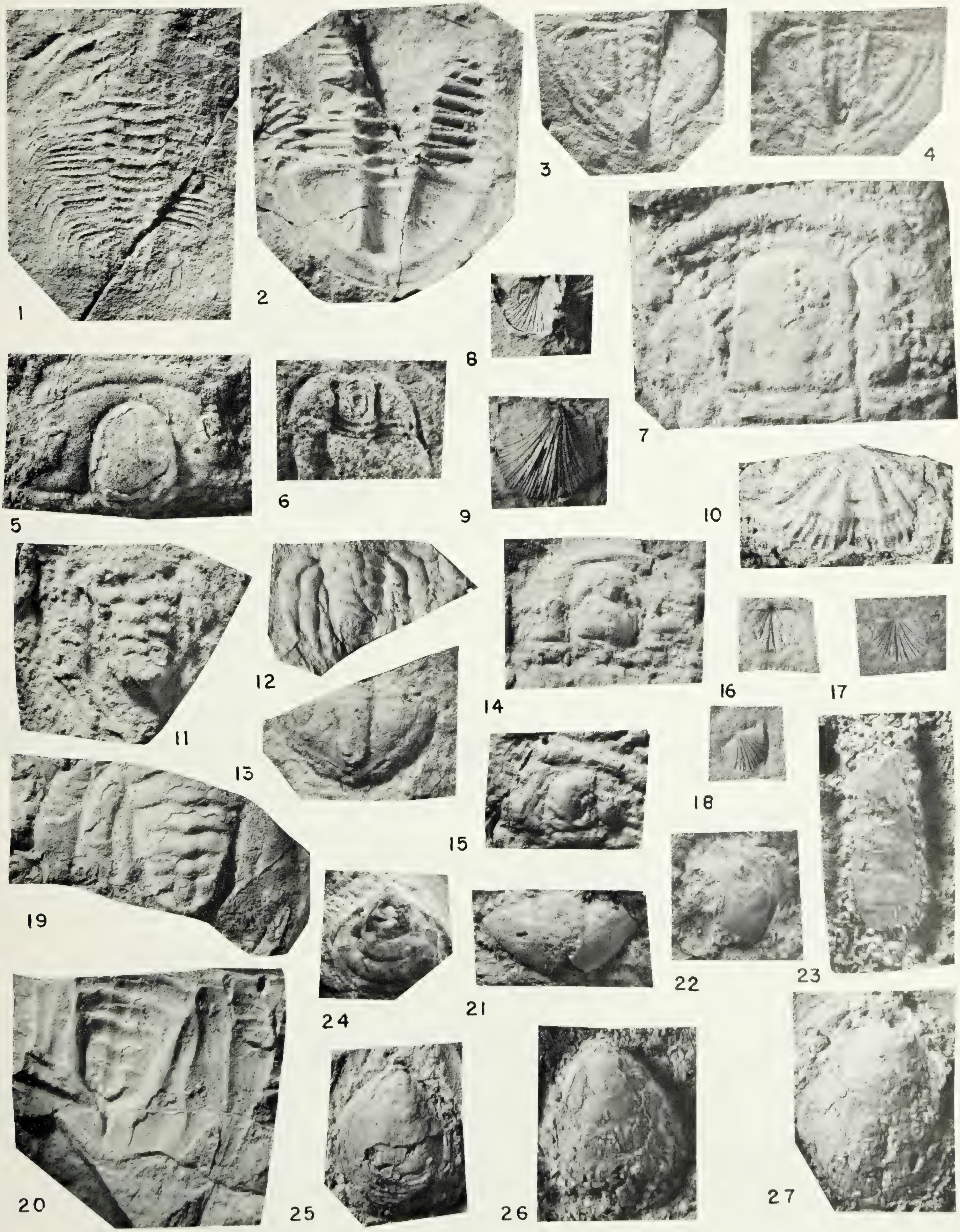
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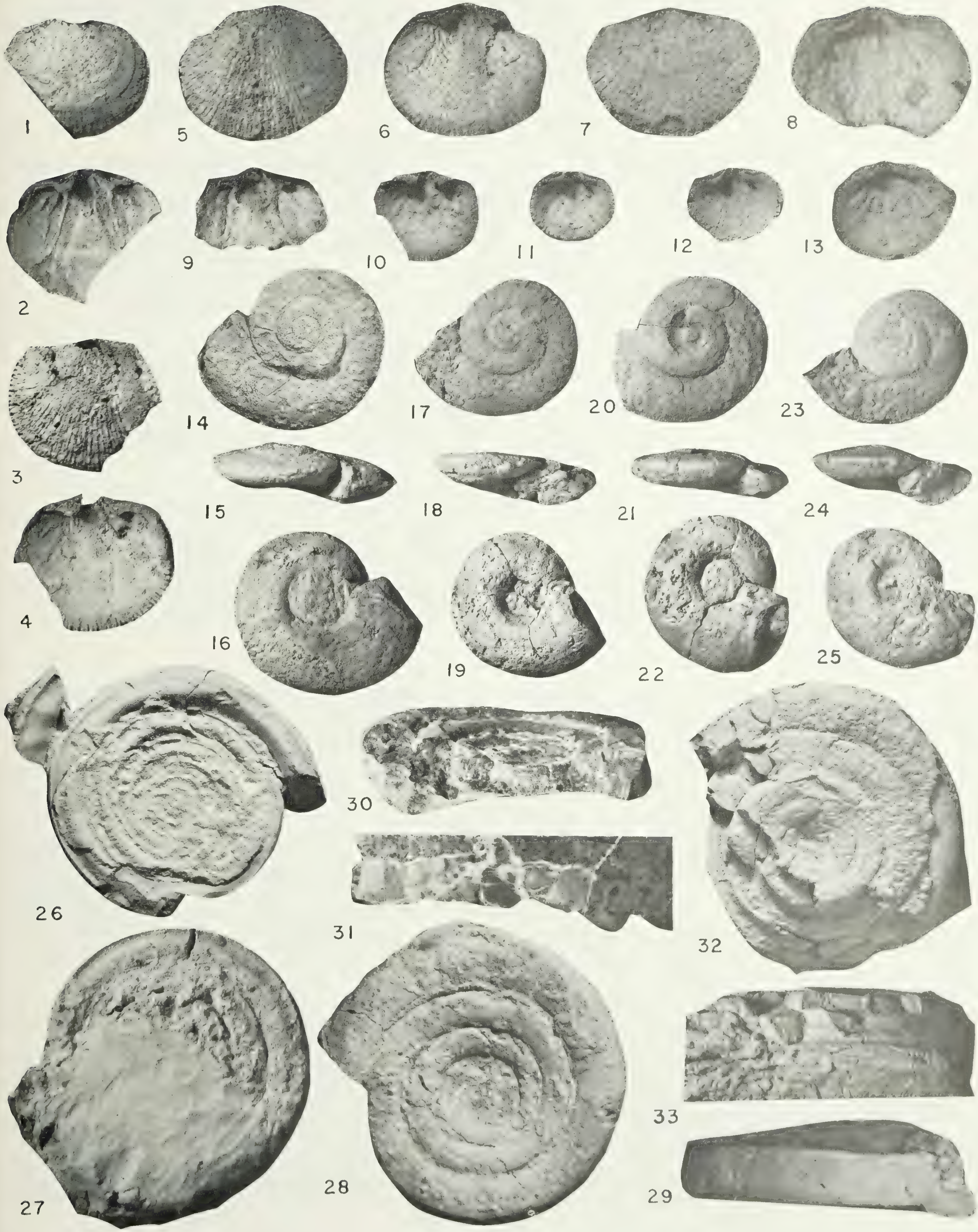
PLATE 3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3, 4. *Lloydia* (*Leiostegium*) cf. *manitouense* Walcott 14
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16. *Hormotoma zelleri* Flower, n. sp. 15
Holotype, ×2, no. 1229, José formation, Cooks Range, New Mexico, ×2.

17. Unidentified pygidium 14
Similar to unidentified pygidium of Zone E of the Ibex region of Utah (Hintze 1952, pl. 8, fig. 12) ×3.4

18, 20-27, 29. *Aulacoparia? huygenae* Flower, n. sp. 12

18. Holotype cranidium, ×3, no. 1263.

20. A tiny immature pygidium, showing pleural furrows externally, ×6. No. 1250

21. A mature pygidium, showing smoothing of pleural and axial furrows, ×2. 1262.

23. A similar pygidium, partly exfoliated, showing pleural furrows on the interior, ×2. No. 1262

22. A pygidium with eight thoracic segments ×2. 1300

24. A free cheek, ×2, no. 1243.

25. Two pygidia, the one on the left exfoliated showing traces of pleural and axial furrows. No. 1247.

26. A large fairly complete cranidium, ×2, no. 1246.

27. The largest cranidium observed, ×2, no. 1245.

29. Pygidium, ×2, no. 1248. Paratype.

All from the José formation of the El Paso group. Most specimens are from the Cooks Range, figs. 22, 27 from the Mimbres Valley section, New Mexico.

19, 28. *Aulacoparia?* sp. 13

19. Cranidium, ×2, showing short preglabellar field, no. 1244.

28. Pygidium, showing an unusually broad border, ×2, no. 1242. Both from the José formation, Cooks Range, New Mexico.

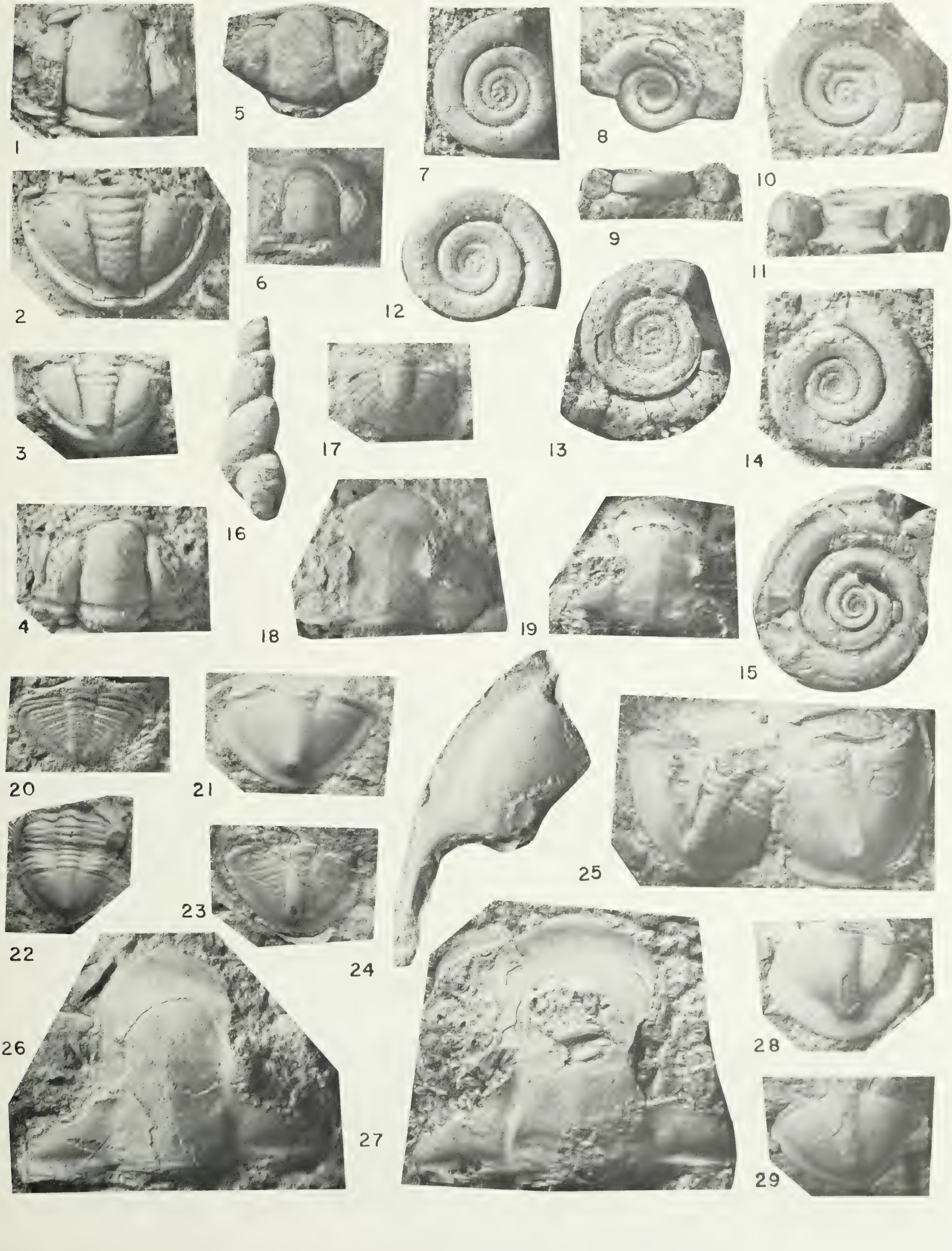
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PLATE 5

Figures *Page*

1-9. *Maclurites nanus* Flower, n. sp. 18
Holotype, ×2, no. 1223, 1, top, 2, side, and 3, base.
Paratype, ×2, no. 1224, 4, top, 5, side, and 6, base.
Paratype, ×2, no. 1225, 7, top, incomplete from weathering, 8, side, and 9, base.

10. *Hormotoma moderata* Flower, n. sp. 18
Holotype, side view, ×2; no. 1227.

11-13. *Sinuopea?* sp. 19
No. 1230. 11, 12, two side views, 13, top.

14-16. *Plethospira rotunda* Flower, n. sp. 18
14, 15, side views, 16, top, of holotype, no. 1229, ×1.

17-30. *Pararaphistoma lemonei* Flower, n. sp. 17
17, top view of a large but imperfect paratype, no. 1222. 18, top, 19, side and 20, base of holotype, no. 1216. 21, an incomplete shell, showing the whorl cross sections, paratype, no. 1217. 22, top, 23, side, and 24 oblique basal views of a paratype, incomplete adorally. 25, 26, two views of the top, showing growth lines, 27, side, 28 base, of a paratype, no. 1219. 29, top of a large incomplete individual, showing the most perfect smoothing of the surface observed, no. 1220. 30, top view, paratype, no. 1221.

All are silicified shells, etched from a black limestone in the middle of the 225′ of limestone comprising the upper part of the Scenic Drive formation, from Nameless Canyon, due west of Ranger Peak, southern Franklin Mountains, Texas.


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PLATE 6

Figures		Page
1-4, 19, 34.	*Paraplethopeltis carinifera* Flower, n. sp.	27
	1. Holotype cranidium, $\times 3$, no. 1169.	
	2. Paratype, a larger but less perfect cranidium, $\times 2$, no. 1170.	
	3. A free cheek, partly exfoliated, $\times 2$, no. 1174.	
	4. Free cheek, $\times 2$, no. 1171.	
	19. An imperfect pygidium, $\times 2$, no. 1172.	
	34. A smaller more perfect pygidium, $\times 2$, no. 1173.	
5-11.	*Remopleuridella? obtusa* Flower, n. sp.	26
	5-8, Holotype, no. 1164, 5, anterior, normal to the cephalon.	
	6, Oblique anterior, 7, Dorsal, normal to thorax, 8, Lateral. All $\times 2$.	
	9. Paratype, a cranidium, no. 1165, $\times 2$.	
	10. Paratype, cranidium, no. 1166. $\times 2$.	
	11. Paratype, cranidium, no. 1167. $\times 2$.	
12-13.	*Archinacella magna* Flower, n. sp.	26
	Holotype, no. 1175, $\times 1$. 12, dorsal view. 13, lateral view.	
14-16.	*Archinacella parva* Flower, n. sp.	26
	Holotype, no. 1176. 14. lateral, and 15, dorsal views, both $\times 2$. 16, dorsal view, $\times 1$.	
17-18.	*Taeniospira? naticoides* Flower, n. sp.	24
	Holotype, no. 1177. 17, top view, 18, side view, both $\times 2$.	
20, 21.	*Leiocoryphe? lobata* Flower, n. sp.	27
	Holotype, no. 1180, $\times 2$; 20. dorsal. 21. posterior view.	
22, 23, 32.	*Palaeacmea expansa* Flower, n. sp.	25
	Holotype, no. 1183. 22, lateral view, $\times 2$. 23, top view, supposed anterior end below; 24, top view, $\times 1$.	
24, 25.	*Rhachopea angulata* Flower, n. sp.	24
	Holotype, no. 1179, $\times 1$, 24, top view. An anterior quarter whorl, very imperfectly preserved, is not illustrated.	
26.	*Yochelsonella compressa* Flower, n. sp.	25
	Side view, the only surface preservd of a high conical strongly compressed monophacophoran. Holotype, no. 1182.	
27-29.	*Prohelicotoma uniangulata* (Hall)	24
	Holotype, no. 1178. 27, side view. 28, top view. 29, basal view, all $\times 1$.	
30, 31.	*Euconia sinuata* Flower, n. sp.	32
	Holotype, no. 1184. 30, side view. 31, basal view, both $\times 1.5$.	
33.	*Sinuopea* sp.	25
	A weathered section of the only representative of this large *Sinuopea* found in the Smith Basin limestone, no. 1181.	
35.	*Plethospira subangulata* Fower, n. sp.	32
	Top view of holotype, no. 1156.	

All figures except 30, 31 and 35 are from the Lower Canadian Smith Basin limestone, from its type section, ¼- to ⅛ mile east of Smith Basin, New York. Figures 30, 31 and 35 are from the overlying Fort Ann formation, directly above, and less than ⅛ mile farther east in the same section, in pastures on the north side of N.Y. route 149.

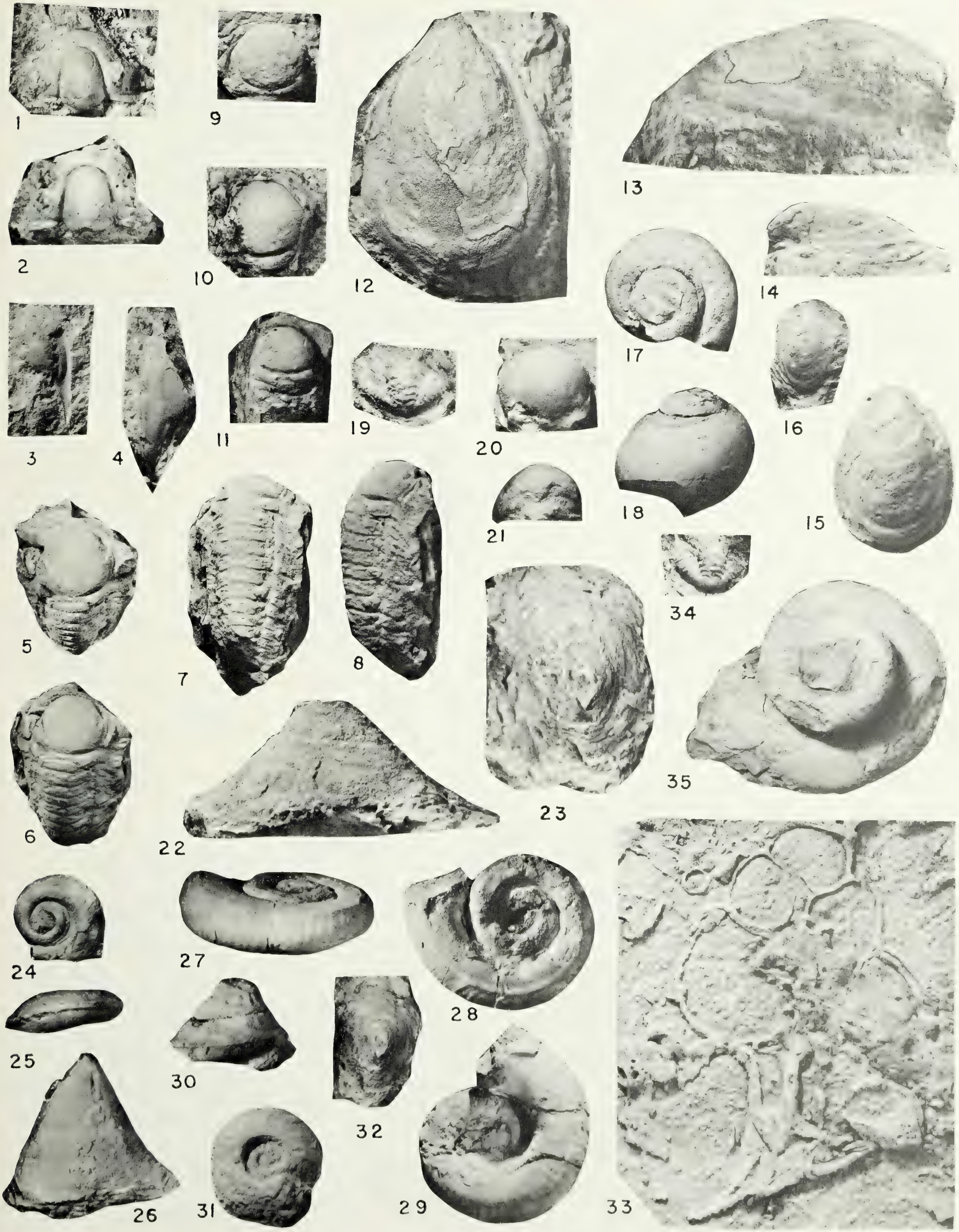
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PLATE 7

Figures		*Page*
1, 14, 16.	*Lesuerilla imperfecta* Flower, n. sp.	32
	1, Paratype no. 1162, a slab containing three imperfect specimens. 14. Paratype, no. 1163. Umbilical surface. 16. Holotype, no. 1161. A partly exfoliated specimen preserving a good cross section. All ×1.	
2, 3.	*Plethospira bilineata* Flower, n. sp.	32
	Holotype, no. 1155, opposite side views, ×1. Fig. 2 shows the two lines limiting the slit.	
4.	*Hystricurus* cf. *conicus* (Billings)	33
	A cranidium tentatively assigned to Billings' species, ×1. No. 1157.	
5-8.	*Diaphelasma* cf. *oklahomense* Ulrich and Cooper	33
	5, 6. two slightly different views of the dorsal interior, ×2. 7, 8, anterior and posterior views, × 1. No. 1215.	
9, 10.	*Plethospira subangulata* Flower, n. sp.	32
	Opposite sides of the holotype, no. 1156, ×1. For apical view see Pl. 6, fig. 35.	
11-13, 15.	*Ophileta macroconica* Flower, n. sp.	33
	11, 12. Side and top views of the holotype, ×1, no. 1158. 13. Upper surface of an incomplete specimen retaining some vestiges of growth lines, paratype, no. 1159. 15. A smaller imperfect paratype, top view, ×1. Missing early whorls may be the result of calcite-filled spaces set off by diaphragms. No. 1160.	

All specimens are in the collection of the writer, from the Fort Ann formation, from the section ¼-⅜ miles east of Smith Basin, on the north side of N.Y. route 149.

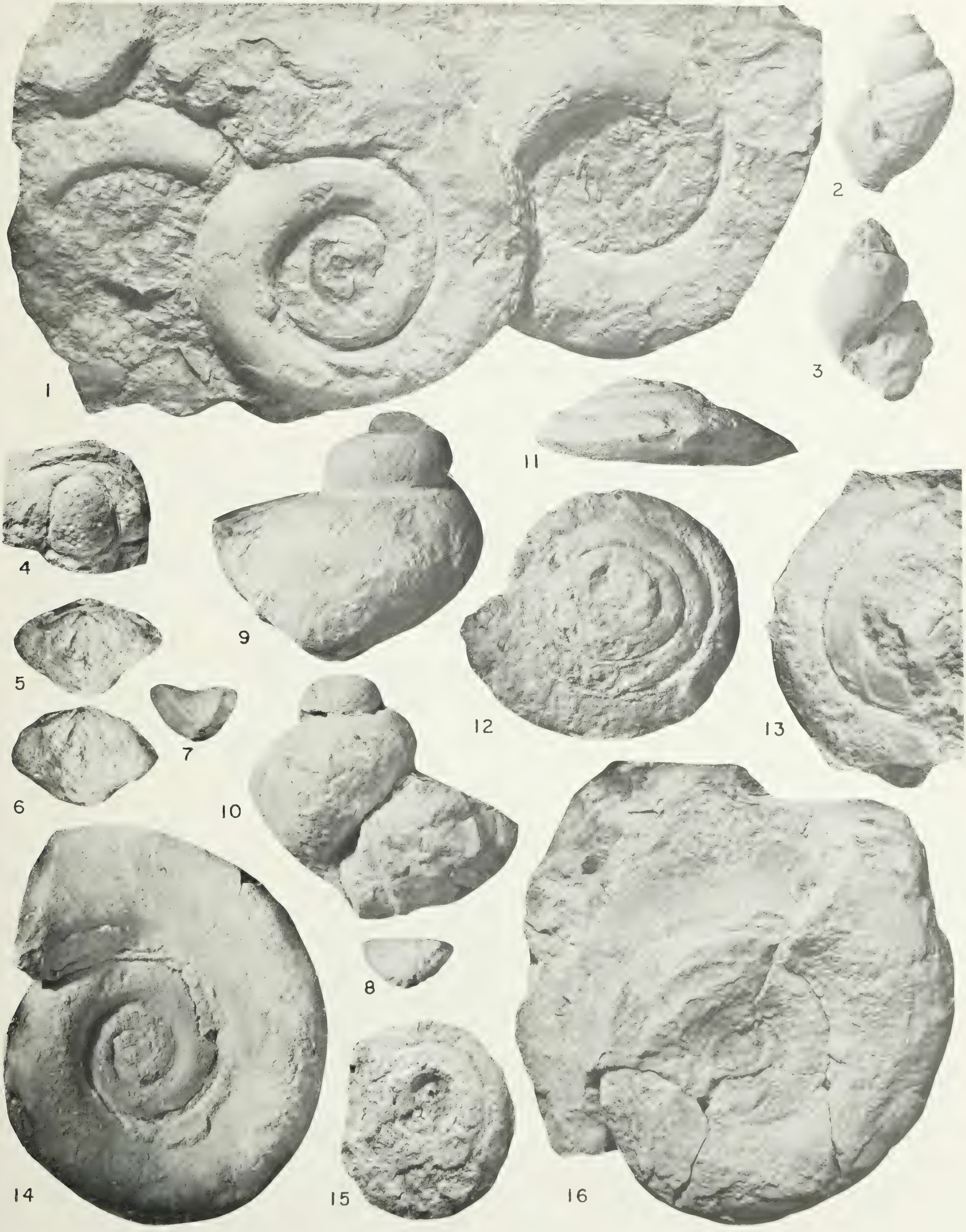
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PLATE 8

Figures *Page*

1-4. *Lemoneitas mirabilis* Flower, n. sp. 38

1. Dorsal view, normal to the prosoma, but oblique to the body. 2. Dorsal view, normal to the body. 3. Lateral view; note wrinkles on the telson. 4. Ventral view. Much of the body is covered by adventitious silica, but a rostral-like structure is evident, and the posterior rings of the last three segments partially embrace the under side.

Holotype, no. 1207.

5-9. *Lemoneites gomphicaudatus* Flower, n. sp. 39

5. Ventral side, showing the underside of the telson relatively smooth, and the posterior ring of the last segment complete across the venter. 6. Lateral view. 7, 8, two dorsal views, at very slightly differing angles and lightings. 9. Lateral view, opposite side from that shown in fig. 6. Paratype, no. 1211.

10-13. *Lemoneites simplex* Flower, n. sp. 39

10. Dorsal view, normal to the prosoma. 11. Dorsal view, normal to the body. 12. Lateral view. 13. Ventral view, showing continuation of posterior rings of the three last body segments across the venter, and a suggestion of a rostum-like structure. Holotype no. 1209.

All are enlarged about 7.5, and are from the *Ceratopea ankylosa* beds, low in the Scenic Drive formation, southern Franklin Mountains, about ⅛ mile north of the Scenic Drive, El Paso, Texas.


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PLATE 9

Figures *Page*

1-5, 11, 12. *Lemoneites gomphocaudatus* Flower, n. sp. 39
Holotype, no. 1210, a nearly complete specimen. 1, Ventral view; 2, oblique ventrolateralview; note contilating of posterior ring of last body segment across the venter. 3, lateral view. 4, 5, two dorsolateral views, with slightly different lighting and position of the specimen. The hump on the back appears to be the right lateral part of some body segments bent over, and subject to excess silicification. 11, 12, dorsal views, slightly different in lightning and focus.

6-8. *Lemoneites ambiguus* Flower, n. sp. 39
Paratype, no. 1214. 6, dorsal view; the displacement of the left side of the prosoma occurred in cleaning, and not prior to burial as with the bending of some body segments in the preceding form. 7, venter, showing a suggestion of a rostrum-like body. 8, lateral.

9-10. *Lemoneites* cf. *gomphocaudatus* 38
A specimen preserving the posterior body segments and part of a telson, club-shaped and pustulose like that of L. gomphocaudatus, but apparently the whole is of more slender proportions. 9, lateral view; 10, dorsal view.

13-15. *Lemoneites* cf. *mirabilis* 38
No. 1208, a fragment too incomplete for certain identification, but showing posterior body segments and a telson similar to those of *L. mirabilis,* from a specimen evidently somewhat larger than the type.

16, 17. *Lemoneites ambiguus* Flower, n. sp. 39
Holotype, no. 1213, 16, lateral view, 17, dorsal view. The under surface shown no organic features.

All are enlarged about 7.5, and are from the *Ceratopea ankylosa* beds, low in the Scenic Drive formation, southern Franklin Mountains, about ⅛ mile north of the Scenic Drive, El Paso, Texas.


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